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Operating Instructions
S700 Series

Extractive Gas Analyzers

Endress+Hauser
People for Process Automation

Described product
Product name: S700
Versions: S710
S710 CSA
S711
S711 CSA
S715 standard
S715 CSA
S715 Ex
S720 Ex
S721 Ex
2025-10 Firmware: As from version 1.6
The special functions for the water analyzers of the TOCOR Series are not described in this document.

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1 About this document

1.1 Symbols and document conventions

1.1.1 Warning symbols

Symbol	Meaning
	Hazard (general)
	Hazard through voltage
	Hazard in potentially explosive atmospheres
	Hazard through explosive substances/mixtures
	Hazard through toxic substances
	Hazard through acidic substances
	Hazard through high temperature or hot surfaces
	Hazard through flammable substances
	Hazard for the environment/nature/organic life

1.1.2 Warning levels and signal words

DANGER:
Risk or hazardous situation which *will* result in severe personal injury or death.

WARNING:
Risk or hazardous situation which *could* result in severe personal injury or death.

CAUTION:
Hazard or unsafe practice which *could* result in less severe or minor injuries.

NOTE:
Hazard which *could* result in property damage.

1.1.3 Information symbols

Symbol	Meaning
EX	Information on product characteristics with regard to protection against explosions
!	Important technical information for this product
↯	Important information on electrical or electronic functions

1.2 Additional documents

Separately supplied document:

- Certificate of Conformity (contains the applied standards and directives)

Additional documents, if applicable:

- CSA Certificate of Compliance
- Statement of Conformity on use in potentially explosive atmospheres
- EU Type Examination Certificate

NOTE:
- ▶ Observe the supplied documents.
- ▶ Pay primary attention to any individual information provided.

Many specifications of the certification documents are considered in this document. However:
- ▶ For legal and official consequences, refer to the original certificates.

1.3 Data integrity

Endress+Hauser uses standardized data interfaces, such as standard IP technology, in its products. The focus here is on the availability of the products and their properties.

Endress+Hauser always assumes the integrity and confidentiality of data and rights affected in connection with the use of the products are ensured by the customer.

In all case, the appropriate security measures, for example, network separation, firewalls, virus protection and patch management, must always be implemented by the customer depending on the situation.

2 Safety instructions

2.1 Primary safety notes

Dangerous sample gases

WARNING: Hazards through dangerous sample gases

- *If the sample gas can be dangerous to health:* Escaping sample gas can be an acute danger for persons.
- *If the sample gas is combustible and/or ignitable*: A defective sample gas path or a leak in the analyzer can produce an ignitable, explosive gas mixture.
  - If the pressure in the sample gas path is > ambient pressure, this gas mixture can occur in the enclosure interior.
  - If the pressure in the sample gas path is < ambient pressure, such a gas mixture can occur in the sample gas path.

▶ Gas mixtures with flammable components > LEL without oxidizing agent: These gas mixtures are not explosive because no oxidizing agent is contained. During operation and/or adjustments, these gas mixtures must not be mixed with oxidizing agents within the gas path. Example: Do not feed ambient air as zero gas directly before or after feeding gas mixtures.

▶ Carefully observe the safety information and application limitations on the sample gases.

Otherwise operation is not safe.

• General measures for health protection	see “Responsibility of user”, page 18
• Application limitations of the S700 versions	see “The interface converter enables the use of Modbus TCP and remote control via MARC2000.”, page 16
• Safety information on installation	see “Safety information on installation”, page 40
• Safety when opening the enclosure	see “Safety precautions before opening the enclosure”, page 55
• Safety during maintenance and repair work	see “Safety information on disassembly of components”, page 196

Potentially explosive atmospheres

DANGER: Risk of explosion due to improper execution of the work described in these Operating Instructions.

Improper execution of work in the potentially explosive atmosphere can cause serious damage to people and the plant.

▶ Maintenance and commissioning tasks as well as tests should only be carried out by experienced/trained personnel with knowledge of the rules and regulations for potentially explosive atmospheres, especially:
  - Ignition protection types
  - Installation regulations
  - Zone classification

WARNING: Hazards in potentially explosive atmospheres

When the S700 is to be used in a potentially explosive atmosphere:

▶ Carefully observe the applicable safety information in this document.

Otherwise operation is not safe.

• Usage options in potentially explosive atmospheres	see “Characteristics of the enclosure types”, page 21
• Safety information on installation in potentially explosive atmospheres	see “Safety in potentially explosive atmospheres”, page 40

• Safety when opening the enclosure	see “Safety precautions before opening the enclosure”, page 55
• Intact state of the connection cables	see “Visual check”, page 199

2.2 Basic operating notes

Commissioning

▶ Ensure gas-tightness; check the filters, valves etc.,	see “Leak tightness check of sample gas path”, page 201
▶ Prevent condensation in the sample gas path of the gas analyzer.	see “General safety information on installation”, page 40
▶ Perform a calibration after each start-up.	see “Calibration”, page 146
▶ Observe the information on special calibrations.	see “Special calibrations”, page 167
– *Additionally in potentially explosive atmospheres:*	
▶ Make sure the enclosure is tightly closed,	see “Closing the enclosure”, page 57
S715 Ex – if the enclosure was opened: ▶ Perform a leak test.	see “Leak tightness check for the enclosure S715 Ex”, page 203

Operating state

▶ Observe the LEDs:	
– “Function” green = normal state – “Function” RED = malfunction – “Service” YELLOW = need for action	see “LEDs”, page 91
– “Alarm” RED = at least one measured value is beyond a limit value.	see “Setting alarm limit values”, page 114
▶ Observe the status messages on the display.	see “Main menu”, page 96
▶ Perform calibrations at regular intervals.	see “Guideline for calibrations”, page 148

When “Alarm” is indicated

▶ Check the current measured values. Consider the situation.
▶ Perform the measures specified at your site for this situation.
▶ If necessary: Switch the alarm signal off (see “Acknowledging alarms”, page 105).

In hazardous situations

▶ Switch-off the system’s emergency switch or main switch.

The main power switch of the S710/S711 is located on the rear of the enclosure next to the power plug (see Fig. 14, page 62).

Shutdown procedure

▶ *Before shutting down:* Purge the sample gas path with a dry neutral gas to prevent condensation in the measuring system; see “Shutdown procedure”, page 217).

2.3 Intended use

2.3.1 Designated users (target group)

All tasks and measures described in this document should be carried out by *skilled persons* who are *trained* and *qualified* to do the following tasks – properly and suitable for the application:

- Mechanical installation
- Electrical installation
- Device configuration and adaptation
- Handling and supervision during operation
- Maintenance

Moreover, these skilled persons should be familiar with the potential *risks* and *hazards* which might usually occur even if the tasks and measures are carried out skillfully. They should know and follow all the related *safety precautions*.

This document is an important part of the device. Please store this document in a safe place after use.

2.3.2 Designated range of application

Measuring function

Gas analyzers of the S700 series measure the concentration of a particular gas in a gas mixture (sample gas). The sample gas flows through the internal measuring system of the gas analyzer. If the S700 is equipped with more than one analyzer module and/or with the MULTOR analyzer module, the concentration of more than one gas component can be measured simultaneously.

Areas of usage

- *Indoor use:* Gas analyzers of the S700 series are designated for indoor use. Direct influence of the atmospheric weather (wind, rain, sun) could damage the device and can have a severe effect on measuring precision.
- *Application limitations:* The area of usage is limited depending on the enclosure type (see “Characteristics of the enclosure types”, page 21).

WARNING: Risk of explosion - health risks

- ▶ Observe the stated application limitations; see “Characteristics of the enclosure types”, page 21.
- ▶ Observe the general measures on health protection; see “Responsibility of user”, page 18.

2.3.3 Interface converter

- The interface converter enables the use of Modbus TCP and remote control via MARC2000.
- The interface converter may only be operated in a secure network.

2.4 Application limitations (overview)

WARNING: Risk of explosion - health risks

- ▶ Observe the stated application limitations; see “Characteristics of the enclosure types”, page 21.
- ▶ Observe the general measures on health protection; see “Responsibility of user”, page 18.

Use in potentially explosive atmospheres

The usage options in potentially explosive atmospheres depend on the enclosure type; see “Characteristics of the enclosure types”, page 21.

Application limitations for explosive/combustible sample gases

- The usage options for measuring combustible gases and explosive gases or gas mixtures depend on the enclosure type and certain conditions; see “Characteristics of the enclosure types”, page 21.

Chemical application limitations

NOTE: Risk of damage

Chemically aggressive gases can damage the measuring system of the gas analyzer. This can make the gas analyzer unusable.

- ▶ Prior to operation, check whether the materials of the measuring system could have been damaged by the sample gas; see “Materials with sample gas contact”, page 248.

Physical application limitations

In some applications, certain gas components could interfere with measurement – for example, because a similar measuring effect is produced and this effect can not be eliminated, due to the laws of nature or technical limitations. A consequence could be that the measured values would shift when the composition of the sample gas has changed, even if the concentration of the measured gas components is still the same.

- ▶ *Whenever the sample gas composition has changed in such cases:* Perform a new calibration using new test gases which correspond to the new conditions.
- ▶ This might not be necessary when the S700 automatically compensates such effects (see “Cross-sensitivity and gas matrix effect compensation”, page 31). For the relevant information, see the delivered documents; in case of doubt, ask the manufacturer.

2.5 Responsibility of user

intended users

The gas analyzer S700 and the interface converter may only be operated by skilled persons who, based on their technical training and knowledge as well as knowledge of the relevant regulations, can assess the tasks given and recognize the dangers involved.

Correct use

- ▶ Use and operate the device only as it is described and specified in these Operating Instructions. The manufacturer is not responsible for any other use.
- ▶ Carry out the specified maintenance tasks.
- ▶ Do not perform any work on the device that is not described in these Operating Instructions.
  Do not remove, add, or change any component in the device unless officially allowed and specified by the manufacturer.
  Otherwise:
  - The device might become dangerous
  - The manufacturer's guarantee becomes invalid
  - The Type Examination Certificate becomes invalid

WARNING: Risk through incorrect use
Equipment-internal protection devices can be impaired when the device is not used as defined.
- ▶ Read these Operating Instructions before installation, start-up, operation and maintenance and observe all information on using the device.

Special local requirements

- ▶ In addition to these Operating Instructions, observe all local laws, technical rules, and company-internal instructions valid at the site where the S700 is used.

Health protection

WARNING: Health risks through sample gas
If the sample gas can be dangerous (for example, corrosive, combustible or ignitable): Escaping sample gas can be an acute danger for persons. The concept of the measuring system must contain the relevant safety measures for health protection. [1]
- ▶ *During installation:* Ensure the safety information on installation is observed; see "Safety information on installation", page 40.
- ▶ *After installation/during operation:*
  - Ensure all persons involved are informed on the sample gas composition as well as know and adhere to the relevant safety measures concerning health protection.
  - *If the leak tightness of the gas paths is questionable:* Perform a leak tightness check; see "Leak tightness check of sample gas path", page 201.

[1] The operating company is responsible for the composition of sample gas and the relevant safety measures.

Preserving the documents

- ▶ Keep the Operating Instructions available for consulting.
- ▶ Pass the Operating Instructions on to a new owner.

3 Product description

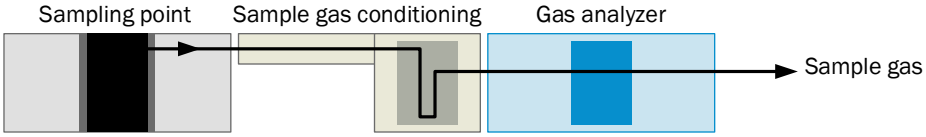
3.1 Application principle

S700 is an extractive gas analyzer with continuous measuring operation:

- *Extractive gas analysis* means that a certain portion of the gas to be analyzed is extracted from the total quantity of the gas (“sample gas” from the “sampling point”) and then passed to the gas analyzer.
- *Continuous measurement* means that a continuous sample gas flow to the gas analyzer is maintained, and that the gas analyzer is continuously delivering current measured values.
- For most applications, a *sample gas conditioning* is required. Depending on the individual application, suitable devices can be:

Particle filters	Protect the measuring system of the gas analyzer from contamination
Heated sample gas lines	Prevent condensation or ice blockages in the sample gas path
Liquid separators	Remove liquids or condensable components from the sample gas
Safety devices	Protect the gas analyzer and the peripheral system against each other (for example, flame arresters in the gas path)

Fig. 1: Extractive gas analysis



- Project notes on extractive sample gas feed see “Designing the sample gas feed”, page 46
- Operating conditions for the sample gas feed see “Connecting the sample gas inlet (SAMPLE)”, page 52

3.2 Product identification

Fig. 2: Type plate S71x (standard)

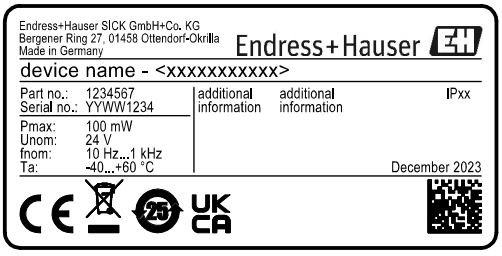


Fig. 3: Type plate S715 Ex

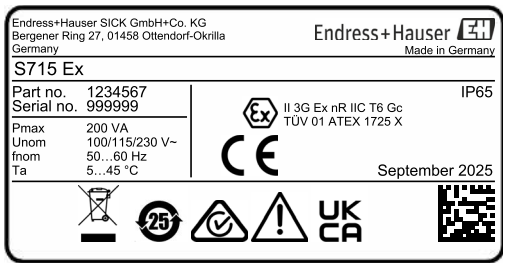


Fig. 4: Type plate S720 Ex

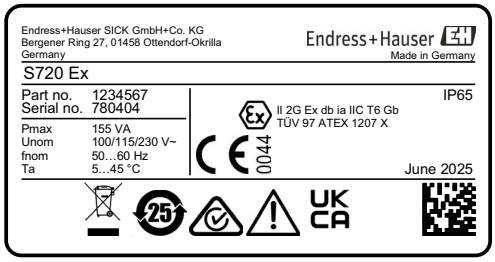


Fig. 5: Type plate S720 Ex (intrinsically safe)

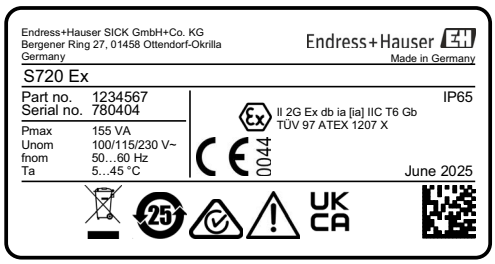


Fig. 6: Type plate S721 Ex

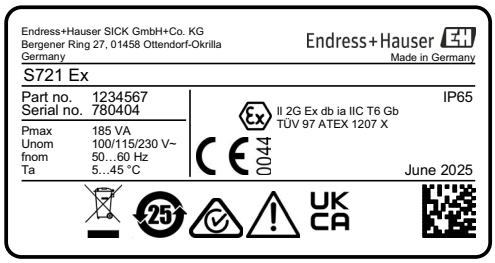
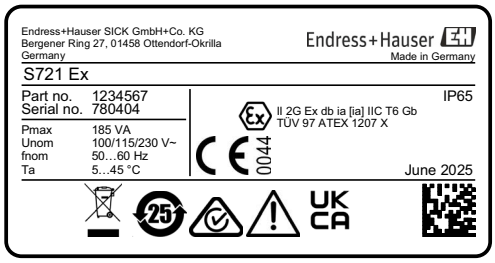


Fig. 7: Type plate S721 Ex (intrinsically safe)



3.3 Characteristics of the enclosure types

WARNING: Risk of explosion - health risks
- ▶ Observe the application limitations of the enclosure types.
- ▶ Observe the general measures on health protection (see “Responsibility of user”, page 18).

3.3.1 S710/S711 · S710 CSA/S711 CSA

Design

- 19" plug-in unit for mounting in standard 19" racks or corresponding outer enclosure.
- S711: Smaller mounting depth, limited set of equipment options.

- Dimensions see Fig. 37, page 238.
- Special characteristics of CSA versions see “CSA versions”, page 27.

Application limitations for enclosure type, S710/S711, S710 CSA/S711 CSA

- Do not use in potentially explosive atmospheres.
- Only use for measurement of combustible gases or gas mixtures when the conditions are fulfilled see Table 1:“Conditions for measuring combustible sample gases and explosive gas mixtures”, page 21.
- Only use for measurement of explosive gases or gas mixtures when the conditions for measuring explosive gas mixtures are fulfilled (see Table 2:“Conditions for measuring combustible sample gases and explosive gas mixtures”, page 23).

Table 1: Conditions for measuring combustible sample gases and explosive gas mixtures

Possible gas concentrations in the sample gas	Consequence for S710/S711/S710 CSA/S711 CSA
Measurement of non-ignitable gas mixtures with combustible gases <25% of the LEL[1]	Measurement is allowed without any further measures.
Measurement of non-ignitable gas mixtures with combustible gases <25% of the LEL including UEL The gas mixture must not be ignitable, i.e. it must not contain any oxidizing agent in the critical concentration (e.g. oxygen limit concentration).	General conditions: • Do not use an internal pump. • Do not use an OXOR-E. • Gases of temperature class T6 may only be measured below 25% LEL. • Ensure compliance with the specified sample gas conditions (pressure, temperature). Further measures: ▶ Ensure an unhindered air exchange between enclosure and environment. ▶ Ensure the sample gas pressure can not exceed the allowable sample gas pressure; see “”, page 243. ▶ Regularly check the leak tightness of the sample gas path: see “Maintenance plan”, page 198. ▶ Tubed sample gas paths are recommended. ▶ For operation in negative pressure: Flame arresters are recommended. Recommendation for device versions with sample gas paths with hoses (especially “Viton”): ▶ Check the material consistency of the hoses every 2 years. Replace the hoses if necessary.

Table 1: Conditions for measuring combustible sample gases and explosive gas mixtures

Possible gas concentrations in the sample gas	Consequence for S710/S711/S710 CSA/S711 CSA
Measurement of ignitable gas mixtures Zone 2 (with combustible gases >25% of the LEL + oxidizing agent)	General conditions: • Do not use an internal pump. • Do not use an OXOR-E. • Gases of temperature class T6 may only be measured below 25% LEL. • Ensure compliance with the specified sample gas conditions (pressure, temperature). Further measures: ▶ Ensure an unhindered air exchange between enclosure and environment. ▶ Ensure the sample gas pressure can not exceed the allowable sample gas pressure; see "", page 243. ▶ Regularly check the leak tightness of the sample gas path: see "Maintenance plan", page 198. ▶ Tubed sample gas paths are mandatory. ▶ Flame arresters are mandatory.

[1] When measuring gases >25% LEL ... <100% LEL, it must be ensured on the process side that the measurement gas remains <100% LEL at all times. Otherwise, the occurrence of a flammable atmosphere must be expected and appropriate safety precautions taken.

3.3.2 S715 standard · S715 CSA

Design

- Closed field enclosure for wall mounting in industrial environment.
- *Upper section:* Electronics, electrical connections.
- *Lower section:* Analyzer modules.
- *Option:* Purge gas connections.

- Dimensions see Fig. 38, page 238.
- Special characteristics of CSA versions see "CSA versions", page 27.

Application limitations for enclosure type S715 standard/S715 CSA

- Do not use in potentially explosive atmospheres.
- Only use for measurement of combustible gases or gas mixtures when the conditions are fulfilled see "Conditions for measuring combustible sample gases and explosive gas mixtures", page 23.
- Only use for measurement of explosive gases or gas mixtures when the conditions for measuring explosive gas mixtures are fulfilled (see "Conditions for measuring combustible sample gases and explosive gas mixtures", page 23).

Table 2: Conditions for measuring combustible sample gases and explosive gas mixtures

Possible gas concentrations in the sample gas	Consequence for S715 standard/S715 CSA
Measurement of non-ignitable gas mixtures with combustible gases <25% of the LEL[1]	Measurement is allowed without any further measures.
Measurement of non-ignitable gas mixtures with combustible gases <25% of the LEL including UEL The gas mixture must not be ignitable, i.e. it must not contain any oxidizing agent in the critical concentration (e.g. oxygen limit concentration).	General conditions: • Do not use an internal pump. • Do not use an OXOR-E. • Gases of temperature class T6 may only be measured below 25% LEL. • Ensure compliance with the specified sample gas conditions (pressure, temperature). Further measures: ▶ Permanent enclosure flushing (30-60 l/h harmless for measurement technology) with instrument air/ambient air for tubed sample gas paths or ▶ Permanent enclosure purging with inert gas (mandatory when using Viton tubing) ▶ Ensure the sample gas pressure can not exceed the allowable sample gas pressure; see “”, page 243. ▶ Regularly check the leak tightness of the sample gas path: see “Maintenance plan”, page 198. ▶ Tubed sample gas paths are recommended. ▶ For operation in negative pressure: Flame arresters are recommended and/or permanent purging with inert gas. Recommendation for device versions with sample gas paths with hoses (especially “Viton”): ▶ Check the material consistency of the hoses every 2 years. Replace the hoses if necessary.
Measurement of ignitable gas mixtures Zone 2 (with combustible gases >25% of the LEL + oxidizing agent)	General conditions: • Do not use an internal pump. • Do not use an OXOR-E. • Gases of temperature class T6 may only be measured below 25% LEL. • Ensure compliance with the specified sample gas conditions (pressure, temperature). Further measures: ▶ Permanent enclosure flushing (30-60 l/h harmless for measurement technology) with instrument air/ambient air or ▶ Permanent enclosure flushing with inert gas ▶ Ensure the sample gas pressure can not exceed the allowable sample gas pressure; see “”, page 243. ▶ Regularly check the leak tightness of the sample gas path: see “Maintenance plan”, page 198. ▶ Tubed sample gas paths are mandatory. ▶ Flame arresters are mandatory.

[1] When measuring gases >25% LEL ... <100% LEL, it must be ensured on the process side that the measurement gas remains <100% LEL at all times. Otherwise, the occurrence of a flammable atmosphere must be expected and appropriate safety precautions taken.

3.3.3 S715 Ex

Design

As S715 standard/S715 CSA, however:

- Restricted breathing enclosure (degree of protection “nr”) for use in potentially explosive atmospheres of Zone 2.
- Internal gas paths tube-connected
- Gas connection for leak tightness check of the enclosure

- Dimensions see Fig. 38, page 238.
- Special characteristics of CSA versions see “CSA versions”, page 27.
- Identification of explosion protection see “Enclosure specifications”, page 240.

ATEX certification for potentially explosive atmospheres (Zone 2)

The ATEX certification for gas analyzers of typeS715 Ex consists of the following documents:

- Statement of Conformity TÜV 01 ATEX 1725 X
- 3rd Supplement to Statement of Conformity TÜV 01 ATEX 1725 X.
- 4th Supplement to Statement of Conformity TÜV 01 ATEX 1725 X.

The “1st Supplement to Statement of Conformity TÜV 01 ATEX 1725 X” and the “2nd Supplement to Statement of Conformity TÜV 01 ATEX 1725 X” apply for S715 versions which are no longer produced.

Application conditions for enclosure type S715 Ex

- Only devices that are non-sparking in operation may be connected to power circuits that are not intrinsically safe in Zone 2 when the devices are suitable for operation in potentially explosive atmospheres in Zone 2 and suitable for the conditions at the installation location.
- The devices may be used to measure media that are not combustible. If the measuring media are combustible, it must be ensured that the concentration of the combustible substance in air does not exceed the lower explosion limit (LEL).
- It must be ensured that no explosive atmosphere is present when the enclosure is open.
- Lay all connected lines fixed.
- The device must not be exposed to direct sunlight or intensive UV light sources; the effect of external heat sources or cooling must be avoided.

Conditions for combustible sample gases

- Only use a gas analyzer type S715 Ex/S715 Ex CSA in potentially explosive atmospheres when one of the following conditions is met: [1]
  - The sample gas is not combustible.

  Or:
  - The concentration of the sample gases is always at max. 25 % of the lower explosion limit.

WARNING: Risk of explosion
▶ Carefully observe and adhere to the application conditions.
Otherwise operation is not safe and there is a risk of explosion.

[1] Specifications of the Declaration of Conformity.

3.3.4 S720 Ex/S721 Ex

Design

- Massive enclosure for use in potentially explosive atmospheres (Ex d).
- Flame arresters in the sample gas connections.
- Three-part enclosure:
  - Analyzer enclosure (analyzer modules, electronics, electrical connections).
  - Satellites: Keypad, display enclosure (permanently connected via cable).
- *S720 Ex:* Smaller analyzer enclosure, limited set of equipment options.

- Dimensions see Fig. 39, page 239.
- Identification of explosion protection see “Enclosure specifications”, page 240.

EU Type Examination Certificate for potentially explosive atmospheres

Gas analyzer types S720 Ex/ S721 Ex are approved according to the EU Type Examination Certificate “TÜV 97 ATEX 1207 X”.

Application conditions for enclosure type S720 Ex/S721 Ex

- Gas analyzer types S720 Ex and S721 Ex and must be included in the local potential equalization. The respective valid installation regulations must be observed.
- Ensure the sample gas pressure can not be greater than 10 kPa (100 mbar). If the sample gas pressure is greater than 100 mbar, an appropriate pressure reducer must be connected upstream.
- When using combustible sample gases, the device version with internally tubed sample gas paths must be used.
- The type ADE 1F2 (INERIS 12 ATEX 0032 X) cable and conduit entry may not be swapped.
- Carbon disulfide is excluded as a sample gas.
- The intrinsically safe measured value outputs are connected to the ground potential for safety reasons. Potential equalization must exist in the entire area of the intrinsically safe power circuits.

WARNING: Risk of explosion
▶ Carefully observe and adhere to the application conditions.
Otherwise operation is not safe and there is a risk of explosion.

Table 3: Conditions for measuring combustible sample gases and explosive gas mixtures

Possible gas concentrations in the sample gas	Consequence for S720 Ex/S721 Ex
Measurement of non-ignitable gas mixtures with combustible gases <25% of the LEL[1]	Measurement is allowed without any further measures.
Measurement of non-ignitable gas mixtures with combustible gases <25% of the LEL including UEL The gas mixture must not be ignitable, i.e. it must not contain any oxidizing agent in the critical concentration (e.g. oxygen limit concentration).	General conditions: • Do not use an internal pump. • Do not use an OXOR-E. • Gases of temperature class T6 may only be measured below 25% LEL. • Ensure compliance with the specified sample gas conditions (pressure, temperature). Further measures: ▶ Ensure the sample gas pressure can not exceed the allowable sample gas pressure; see “”, page 243. ▶ Regularly check the leak tightness of the sample gas path: see “Maintenance plan”, page 198. ▶ Tubed sample gas paths are mandatory. ▶ Flame arresters are mandatory.
Measurement of ignitable gas mixtures Zone 2 (with combustible gases >25% of the LEL + oxidizing agent)	General conditions: • Do not use an internal pump. • Do not use an OXOR-E. • Gases of temperature class T6 may only be measured below 25% LEL. • Ensure compliance with the specified sample gas conditions (pressure, temperature). Further measures: ▶ Ensure the sample gas pressure can not exceed the allowable sample gas pressure; see “”, page 243. ▶ Regularly check the leak tightness of the sample gas path: see “Maintenance plan”, page 198. ▶ Tubed sample gas paths are mandatory. ▶ Flame arresters are mandatory.
Measurement of ignitable gas mixtures Zone 1 (with combustible gases >25% of the LEL + oxidizing agent)	General conditions: • Do not use an internal pump. • Do not use an OXOR-E. • Gases of temperature class T6 may only be measured below 25% LEL. • Ensure compliance with the specified sample gas conditions (pressure, temperature). Further measures: ▶ Ensure the sample gas pressure can not exceed the allowable sample gas pressure; see “”, page 243. ▶ Regularly check the leak tightness of the sample gas path: see “Maintenance plan”, page 198. ▶ Tubed sample gas paths are mandatory. ▶ Flame arresters are mandatory.

[1] When measuring gases >25% LEL ... <100% LEL, it must be ensured on the process side that the measurement gas remains <100% LEL at all times. Otherwise, the occurrence of a flammable atmosphere must be expected and appropriate safety precautions taken.

3.3.5 CSA versions

- CSA versions are for use in the validity range of the CSA.
- For CSA versions, special specifications apply for:
  - Switching outputs (see “Maximum load of the signal connections”, page 66)
  - Power connection (see “Electrical data”, page 242).

Identification of CSA versions see “Product identification”, page 19.

3.4 Know-how for the S700

3.4.1 Special features

• Several analyzer modules: A S700 can contain up to three analyzer modules.	see “Analyzer modules”, page 29
• *Multi-component measurement:* The S700 measures all measuring components simultaneously every 0.5 ... 20 seconds. [1]	see “Combined display for all components”, page 97
• *Cross-sensitivity compensation:* Common measuring influences of the individual gas components can be compensated.	see “Cross-sensitivity and gas matrix effect compensation”, page 31
• *Calibration cuvette:* This option can speed-up routine calibrations of UNOR and MULTOR analyzer modules and reduce test gas consumption.	see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 29
• Configurable signal connections: The S700 has 8 control inputs and 13 switching outputs, with freely assignable functions.	see “Available control functions”, page 122 / “Available switching functions”, page 121
• *Configurable measured value outputs:* The S700 has 4 analog measured value outputs (0/2/4 ... 20 mA). – Which measured value output is used for a certain measuring component can be set. One measured value can also be output on several measured value outputs. – Each measured value output has 2 output ranges. The output ranges are adjustable.	 see “Assigning measuring components”, page 116 see “Setting-up the output ranges”, page 117
• *Digital data output:* The S700 can also transmit the measured values and status messages via a serial RS232 interface.	see “Function of the interfaces”, page 76
• *Chart recorder simulation:* The S700 can display a continuous image of previous measured values.	see “Chart recorder simulation”, page 98
• *Integration of external measured values:* Measuring signals of other devices can be fed and shown the same as internal measuring components	see “Analog inputs”, page 69
• *2 zero gases:* For zero point calibration, the nominal values for two different “zero gases” can be set. This allows calibrating different analyzer modules which require individual zero gases. Cross-sensitivity effects can be compensated with negative nominal values.	see “Cross-sensitivity compensation with OXOR-P”, page 179
• *4 test gases:* For sensitivity calibration, nominal values for four different test gases can be set. Which measuring component is calibrated with which test gas is selectable. Test gas mixtures for the calibration of several measuring components are possible.	see “Test gases for sensitivity calibration”, page 150
• *Data storage:* – The S700 can save copies of the current settings and data, and reactivate these via menu command. – The data of the S700 can be saved on a computer and restored.	 see “Using an internal backup”, page 132 see “Using an external backup”, page 133
• *Remote control:* The S700 can be controlled via a digital remote control. – With “AK protocol” commands. – Via “Modbus” interface.	 see “Remote control with “AK protocol””, page 182 see “Remote control with Modbus”, page 188
• *Firmware update:* The internal software of the S700 can be updated via interface.	see “Firmware update”, page 136

[1] Depending on the number of measuring components and physical measuring range.

3.4.2 Analyzer modules

Depending on its configuration, the S700 can measure up to five gas components simultaneously. For this purpose, up to three different analyzer modules (physical measuring systems) can be installed.

An analyzer module contains the physical analysis unit and basic electronic circuits. The different analyzer module types use individual measuring principles and therefore have specific physical characteristics.

The analyzer module fitted in the device is noted on the type plate and can be shown on the display; see “Display of device data”, page 102.

Table 4: Analyzer modules for the S700

Analyzer module	Measuring principle	Measuring components, application
MULTOR	NDIR [1]	2 ... 4 NDIR measuring components
UNOR	NDIR [1]	1 NDIR measuring component
OXOR-P	Paramagnetism	O_2, high requirements (see “Analyzer modules for O_2 measurement”, page 30)
OXOR-E	Electrochemical cell	O_2, standard requirements (see “Analyzer modules for O_2 measurement”, page 30)
THERMOR	Thermal conductivity	H_2, CO_2, He and others
THERMOR 3K	Thermal conductivity	H_2/CO_2 special application (see “Special version “THERMOR 3K””, page 222)

[1] Non-dispersive infrared absorption (optical cuvette; selective pneumatic detector).

See separate data sheet for characteristics and possible combinations of the analyzer modules.

3.4.3 Calibration cuvette for analyzer modules UNOR and MULTOR

The option “calibration cuvette” allows performing routine sensitivity calibrations for the analyzer modules UNOR and MULTOR without using special test gases – only a “zero gas” is required.

A calibration cuvette contains a test gas mixture for the sensitivity calibration and can be rotated into the optical path of the analyzer module.

During the calibration, zero gas flows permanently through the analyzer module. The first step is a zero point calibration. When the sensitivity calibration starts, the calibration cuvette is automatically moved into the optical path, and the test gas mixture in the calibration cuvette simulates the presence of a test gas in the measuring cuvette.

The nominal values of this simulation are first determined and programmed at the factory. During operation, these nominal values only have to be checked and adjusted from time to time (recommendation: every 6 months; procedure see “Calibration of the calibration cuvette (option)”, page 173).

3.4.4 Analyzer modules for O_2 measurement

OXOR-E (electrochemical cell)

The OXOR-E module has an electrochemical O_2 sensor which is filled with an electrolyte. A PTFE membrane is used to let O_2 molecules diffuse into the sensor. The O_2 molecules are chemically transformed on a metal electrode. This chemical reaction produces an electric current which is measured.

Because the chemical reaction consumes the electrolyte, the O_2 sensor needs to be replaced after a certain period of use. The normal sensor life may be reduced by disadvantageous sample gas mixtures, for example, low moisture (see “”, page 243), aerosoles and high SO_2-concentrations.

Further information see “Replacing the O_2 sensor in the OXOR-E module”, page 205.

OXOR-P (paramagnetic measuring cell)

The OXOR-P analyzer module contains a diamagnetic dumbbell which is suspended in a magnetic field in such a way that it could rotate out of this field. An opto-electronic compensation circuit is used to keep the dumbbell in a defined resting position.

The sample gas flows through the measuring cell. If the sample gas contains O_2, the paramagnetic characteristic of O_2 will change the magnetic field. This causes an adaptation of the opto-electronic compensation, which is read by the software and evaluated as an O_2 concentration change.

The selectivity of the OXOR-P module is based on the exceptionally high magnetic susceptibility of oxygen. The magnetic characteristics of other gases are so small in the relation that they do not need to be considered, usually. However, if there are sample gas components which also have a relatively high magnetic susceptibility, then measurement errors might occur. There are several methods for compensation (see “Cross-sensitivity compensation with OXOR-P”, page 179).

3.4.5 Cross-sensitivity and gas matrix effect compensation

Physical interferences

It is possible that a particular gas component disturbs the measurement of another gas component – by producing a similar measuring effect or by interfering with the desired measuring effect. There are applications where this effect cannot be avoided due to the laws of nature or due to technical limitations. In such cases, the gas analyzer would not only respond to the specific measuring components, but also to the interfering gas component. As a result, the measured values would be incorrect.

Two technical expressions are used to describe the possible physical effects:

“Cross-sensitivity”

A cross-sensitivity occurs when the interfering gas component produces an additional measuring effect. The main characteristic of a cross-sensitivity is that the analyzer still displays a measured value even when the measuring component is not present in the sample gas (interfering effect at zero point). A constant concentration of the interfering component will produce a constant “offset” over the complete measuring range. When the interfering concentration changes, the offset will change accordingly.

“Carrier gas effect”

A carrier gas effect interferes with the required measuring effect. This changes the measuring sensitivity. The characteristic is that the deviation increases for higher measured values. This effect also fluctuates with the concentration of the interfering component.

Compensation

The following options are available to compensate for such interfering effects:

- *Internal cross-sensitivity compensation:* For this option, the S700 must also measure the concentration of the interfering gas component. A basic calibration is performed at the factory where S700 “learns” how the measurements influence each other. Thereafter the S700 software can compensate for the interfering effect and will produce technically corrected measured values. In addition, the S700 can consider whether the cross-sensitivity effect also occurs during a calibration or not (see “Calibration of cross-sensitivity compensations (option)”, page 177).
- *External cross-sensitivity compensation:* The S700 has to be fed with an analog measuring signal, which represents the current concentration of the interfering gas component (see “Analog inputs”, page 69). This method can also be used to compensate other interfering effects. Because of the manifold application options, this option normally requires an individual adaptation of the S700 software.
- *Carrier gas compensation:* As for the internal cross-sensitivity compensation, the S700 additionally has to measure the concentration of the interfering gas component and “learn” during a basic calibration at the factory how to compensate the interfering effect.
  – Consider for calibrations that only the test gas used for calibrating the sensitivity of “interfering components” may contain the interfering gas components; all other calibration gases must not contain the interfering components, otherwise the calibration is erroneous.

- If your S700 is working with an automatic compensation, please observe the information in Automatic compensations”, (see page 224).
- To find out whether your S700 is working with one of these options, read Information on active compensations”, (see page 224).

3.5 Optional equipment

Some usage options depend on whether your S700 is equipped with a particular option (see following Tables). Please observe the individual order and delivery information for your device.

Table 5: Hardware options

Option	Effect	possible in
Built-in gas pump	Delivers a gas flow (for example, sample gas). The pump capacity can be adjusted via menu function (see “Setting the gas pump capacity”, page 137).	S700
Condensate sensor	Protection of the gas analyzer: The electrical conductivity of a liquid in the gas path generates an error message and automatically shuts down the gas pump.	
Flow sensor	Monitoring the gas flow: Generates an error message when the gas flow is lower than the set limit value (see “Setting the flow monitor limit value”, page 137).	
Atmospheric pressure sensor	Compensation of the gas pressure: The measured pressure value is used to compensate the physical influence of the pressure.	
Sample gas pressure sensor		
2 separate gas paths 3 separate gas paths	Analysis of two independent sample gases; mathematical linking of the measured values is possible.	
	Reference measurement: The second sample gas serves as physical span gas in the analyzer module.	S700 with UNOR / THERMOR
Calibration cuvette	Sensitivity calibration of UNOR/MULTOR without test gases (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 29).	S700 with UNOR / MULTOR
Intrinsically-safe measured value outputs	Increased electrical safety in potentially explosive atmospheres (see “Intrinsically-safe measured value outputs”, page 74).	S715 S720 Ex S721 Ex
Purge gas connections	Explosion or health protection: Purging of the enclosure with a neutral gas (see “Purge gas connections (option)”, page 53).	S715 standard S720 Ex S721 Ex
Enclosure ventilation	Increased health protection against overpressure in the enclosure (see “Enclosure venting (option)”, page 54)	S720 Ex S721 Ex

Table 6: Software options

Option	possible in
Second output range for each measured value output	S700
Switch ratio between two output ranges is larger than 1:5 or 1:10	
Remote control functions related to the “AK protocol” standard of the German automobile industry (see “Remote control with “AK protocol””, page 182)	
Remote control functions with “Modbus” commands (see “Remote control with Modbus”, page 188)	
Sampling point selector (see “Sampling point selector (option)”, page 142)	
Showing external analog measured values as an internal measuring component (see “Analog inputs”, page 69)	
Computation of measured values from an external analog signal (see “Analog inputs”, page 69), including calibration and display as an internal measuring component	
External cross-sensitivity compensation using a fed analog measured value (see “Cross-sensitivity and gas matrix effect compensation”, page 31)	
Internal cross-sensitivity compensation (see “Cross-sensitivity and gas matrix effect compensation”, page 31)	S700 with multiple analyzer modules and/or MULTOR

3.6 User Guide for the S700

3.6.1 What must you do?

To measure with the S700, the following tasks must be carried out:

Install the S700

– Check the ambient conditions . . . 44
– Install the analyzer enclosure . . . 45
– Properly condition the sample gas . . . 46
– Connect sample gas feed . . . 46
– Connect mains power . . . 60
– Tightly close the enclosure (only S715 Ex, S720 Ex, S721 Ex) . . . 55
– For option “purge gas connections”: Feed purge gas if necessary . . . 53
– For option “external cross-sensitivity compensation”: Feed analog signal . . . 69

Start-up the S700 . . . 77

– LEDs . . . 91
– Measured value display . . . 92
– Principle of operation . . . 93
– Menu levels . . . 95

Prepare for operation

– Switch on sample gas pump (if fitted or controlled by the S700) . . . 104
– Set the capacity of the built-in sample gas pump (option) . . . 137
– Set the automatic test gas delay time . . . 161
– Set/check the calibration measuring interval . . . 162
– Perform a calibration . . . 146

Perform routine maintenance on the S700

In general:

– Perform calibration at regular intervals . . . 146
– Maintenance plan . . . 198

Please observe the special information on the “THERMOR 3K” analyzer module (see “Special version “THERMOR 3K””, page 222).

3.6.2 What can you do in addition?

The following S700 functions can be used and adapted as required:

Menu language 109

Measured value outputs
– Connection 68
– Assignment of the measuring components 116
– Start value, end value and switch-over point of an output range 117
– Live zero point (0/2/4 mA) 118
– Selection of the output ranges 118
– Control input for external output range switching 122
– Output range status contact 121
– Function during calibrations 119

Damping
– Floating average value computation 111
– Dynamic damping 112

Programmable status and switching outputs
– Configurable functions 121
– Connection 70

Programmable control inputs
– Configurable functions 122
– Connection 73

Sampling point selector (option)
– Configuration of the switching function 142
– Configuration of associated switching outputs 120

Limit values for “Alarm” messages
– Set the limit values 114
– Configuration of associated switching outputs 120
– Connection of the switching outputs 65

Automatic calibrations
– Possible configurations 157
– Essential preparation (overview) 156
– Limit values for drift monitoring 160

Digital interfaces
– Interface connections 76
– Set the interface parameters 124
– Automatic data outputs 125

Remote control
– With “limited AK protocol” option 182
– With “Modbus” protocol 188

Save internal analyzer data
– Save and restore settings in the S700 132
– Save and restore data via computer 133

3.6.3 If you first wish to learn about the operating functions ...

... you can do the following:

Provisionally start-up the S700

1. Do not install the S700 immediately at the planned usage location but first at a location where you can easily operate it, for example, in your office. Leave the S700 gas connections closed until final installation is complete.
2 Connect the mains power; see “Power connection”, page 60.
3 Start-up the S700; see “Switch-on procedure”, page 89.

Familiarize yourself with the operating controls

Please read the introduction to the operating principle; see “Principle of operation”, page 93. Have a look at the menu system. You won’t do anything wrong if you pay attention to the following:

- Storing a new value requires pressing the [Enter] key. Therefore, do not press [Enter], but [Esc] to leave the particular menu. In this way, the status will remain unchanged.
- If you have started a test calibration and you are prompted to `Save: Enter,` do not press [Enter] but [Esc] instead, because the calibration should not be changed under provisional conditions.

If the S700 is equipped with a built-in sample gas pump and you switch on the pump to check its function, please switch it off after a few seconds. It is not recommended to operate the pump when the gas paths are closed.

3.7 Interface converter

Two applications are feasible with the “Ethernet interface converter” option.

3.7.1 Application case 1 - Virtual serial interface

In this application case, the interface converter makes the serial interface of the S700 available to remote PCs via the network. An additional program which can be downloaded from PhoenixContact is required for use.

Once the connection has been established, the virtual serial port of the accessing PC can be used for the following tasks:

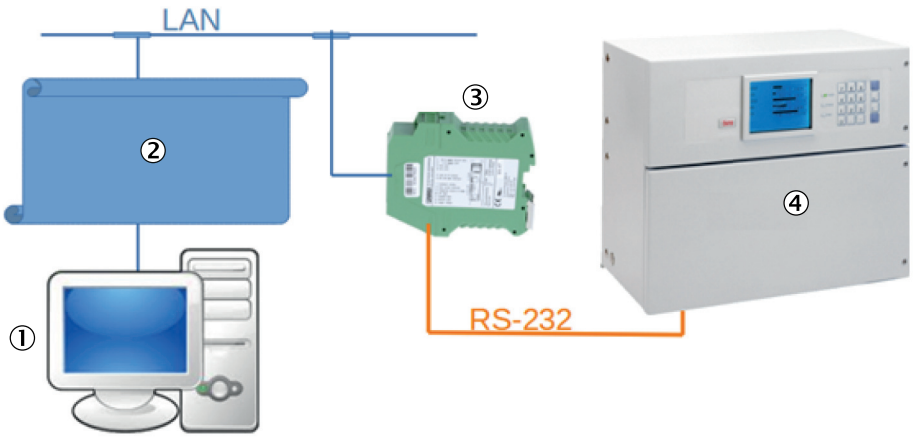
- Remote control of the device via Endress+Hauser “MARC2000” software
- After activating the Modbus ID in the S700: Communication with the device via Modbus RTU

With an existing Meeting Point Router (MPR) from Endress+Hauser, remote maintenance by Support is also possible without setting up a virtual port.

Functional principle

A COM port redirector driver is installed on the PC, which provides a virtual COM port. When the virtual COM port is opened, the driver connects to the IP of the FL-COM server via the network connection and sends the serial data to the FL-COM server via the network. The FL-COM server “translates” the incoming data back into the serial RS232 format and then uses this serial connection to communicate with the S700.

The Figure below shows the setup with description.



1 PC with LAN connection
2 Virtual Com port (driver)
3 FL-COM server
4 S700 (Figure may differ)

Fig. 1: Application case - Virtual serial interface

3.7.2 Application case 2 - Modbus TCP gateway

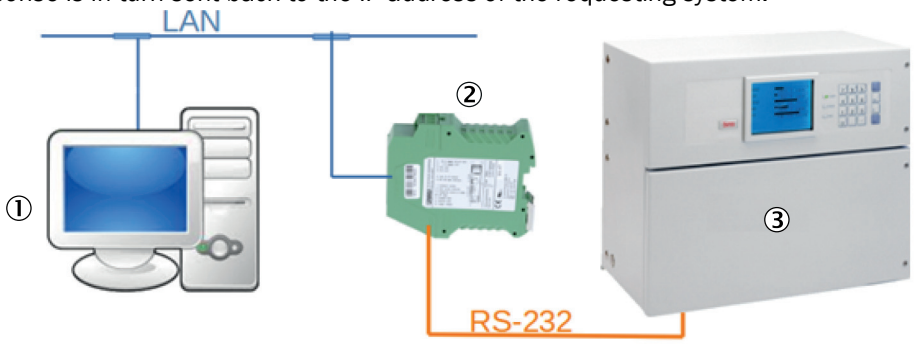
In this application case, the interface converter is used to translate the Modbus RTU (serial) protocol to Modbus TCP Client (Ethernet) (gateway). This makes the Modbus of the S700 accessible to higher-level systems via Ethernet. In contrast to serial communication, it is also possible for several systems to access at the same time.

The following tasks can be implemented:

- Integration of the S700 in Modbus TCP communication networks

Functional principle

The interface converter is operated in “Modbus/TCP” mode. Port 502 is opened at the set IP address of the interface converter and the interface converter is then available as Modbus TCP server. The content of incoming Modbus TCP requests is extracted and the message is forwarded to the device whose ID is contained in the telegram. The device’s response is in turn sent back to the IP address of the requesting system.



1 PC with LAN connection
2 FL-COM server
3 S700 (Figure may differ)

Fig. 2: Application case - Modbus TCP gateway

4 Installation

4.1 Scope of delivery

Unpack and check

1. Open the transport container.
2. Remove the protective packing.
3. Remove the components carefully out of the case.
4. Check that all required parts have been delivered with your device; (see Table)7.

To protect the internal gas path, the gas connections are closed with plugs. Please do not remove these plugs until you connect the gas lines.

Table 7: Scope of delivery

Analyzer	Scope of delivery
All S700	Gas analyzer, complete
	Plug-in connectors with cable terminals, each can be mechanically coded [1]
	Operating Instructions
	EU Declaration of Conformity
S710 S710 CSA S711 S711 CSA	Power cable, 2 m long
S715 standard S715 CSA S715 Ex	Bulkhead fittings for the gas connections [2]
	Sealing caps for closing unused cable gland bores
	TX25 hexagon socket wrench for the front screws
	Type examination certificate *(only S715 Ex)*
S720 Ex S721 Ex	Aids to open the analyzer enclosure [3]
	Ferrite rings [4]
	Cable straps to fix the ferrite rings [4]
	Wire-netting straps [4]
	Hose clamps to fasten the wire netting straps [4]
	EU Type Examination Certificate

[1] Standard: 6 pieces; adjusted delivery configuration: 3 pieces. Application see “Type of terminal connections”, page 65.
[2] Number and layout depending on the individual device version.
[3] Application see “Opening the enclosure”, page 56.
[4] One for each cable inlet. Application see “Correct installation of cables”, page 59.

4.2 Safety notes on transport

4.2.1 General safety information on lifting and carrying

WARNING: Risk of accidents due to incorrect lifting and carrying

Moderate to severe injuries as a result of tipping (mass of the device) and/or due to protruding enclosure parts.

To lift the device:

- Consider the device weight before lifting.
- Wear skid-proof gloves and safety shoes with lifting the device.
- Do not use protruding parts on the enclosure to carry the device (exceptions: wall fixture, carrying grips).
- Never lift the device using the open device door.
- Grip underneath the device when possible to carry it safely.
- Call in further personnel as assistants as required.
- Use a hoist or transport equipment as an option.

To transport the device:

- Before transport:
  - Ensure obstacles that could cause falls or collisions are cleared away.
  - Prepare the target location for the installation of the device (for example, cable connections).
- Take complex enclosure parts into account (for example, when rotating the device).
- Secure the device during transport.

4.2.2 Special safety information on the enclosures

S710/S711

CAUTION: Risk of injuries

The enclosure has sharp edges.

- When lifting or carrying the device, take care that nobody can be injured.

S715

CAUTION: Risk of injuries and accidents due to heavy weight

- Wear skid-proof gloves and safety shoes with lifting the device.
- Do not use gas connections or cable inlets as lifting points.

S720 Ex/S721 Ex

CAUTION: Risk of injuries and accidents due to heavy weight and complex enclosure parts

An S720 Ex/S721 Ex consists of multiple heavy enclosure parts which are connected with fixed cables. The analyzer enclosure weighs at least 75 kg (S720 Ex) and/or 115 kg (S721 Ex).

- Call for assistance to transport the complete device.
- Use a hoist or transport equipment as an option.
- Wear skid-proof gloves and safety shoes.
- Do not use the cable inlets or gas connections as lifting points.

4.3 Safety information on installation

4.3.1 General safety information on installation

WARNING: Accident risk

Risk of injury due to improper installation or operation.

Installation, commissioning and maintaining the device should only be carried out by skilled persons who, based on their technical training and knowledge as well as knowledge of the relevant regulations, can assess the tasks given and recognize the dangers involved.

Before installation, commissioning, operation and maintenance:

- ▶ Read and observe the Operating Instructions.
- ▶ Observe the safety instructions.
- ▶ Do not interfere with the device's internal protective devices.
- ▶ Only use Endress+Hauser spare parts.

WARNING: Accident risk

Risk of injury due to insufficient fastening

- ▶ Observe the weight specifications of the device when selecting the brackets.
- ▶ Before mounting the device, check the condition of the wall and the load-bearing capacity of the rack.
- ▶ Consider the vibration load.

NOTE: Responsibility for system safety

The installer of the system is responsible for the safety of the system in which the gas analyzer is integrated.

4.3.2 Safety in potentially explosive atmospheres

WARNING: Risk of explosion for S710/S711/S715

- ▶ Do not use a S710/S710 CSA, S711/S711 CSA, S715 standard or S715 CSA in potentially explosive atmospheres.

This enclosure type is not suitable for this use.

WARNING: Risk of explosion for S720 Ex/S721 Ex/

- ▶ *If a S715 Ex, S715 Ex CSA, S720 Ex or S721 Ex is used in a potentially explosive atmosphere:* Carefully observe the relevant information on the enclosure type.
  - – see “S715 Ex”, page 24
  - – see “S720 Ex/S721 Ex”, page 25

4.3.3 Safety instructions for electrical safety

WARNING: Dangerous electrical voltage

Risk of accident due to electric shock

- Ensure disconnection of the power supply via an easily accessible and marked disconnector and/or circuit breaker.
- *When using a 24 V PELV power supply unit:* Position the disconnecting switch before the power supply unit.
- *When working on the device:*
  - Only allow work to be carried out by qualified electricians familiar with the possible dangers.
  - Take suitable protective measures against local and plant-related hazards (for example, free movement areas, cable ducts, automatic restart).
  - Disconnect the power connections or power supply lines from the power supply before working on the device.
  - Power supply must have a functioning protective conductor (protective earth, PE).
  - Activation of the power supply only by the executing personnel in compliance with the valid safety regulations.
  - Reattach removed contact protection before switching on the power voltage.
- *When replacing a detachable power cable:* Observe the specifications in the Operating Instructions.
- *For external heating cables operated with power voltage:* Ensure sufficient conductor cross-section.
- *If the device is visibly damaged:* Switch the power supply off externally.
- Only use electrical fuses that comply with the specified characteristics (type, breaking current, tripping characteristics).

WARNING: Further hazards due to electrical voltage

- see “Safety information for power connection”, page 60
- see “Installing a separate disconnector switch”, page 61

NOTE: Sensitive electronics

Before signal connections are established (also with plug connections):

- Disconnect the S700 and connected devices from the power supply (switch-off).

Otherwise the internal electronics could be damaged.

4.3.4 Heat safety instructions

WARNING: Hazard from hot surfaces

Risk of skin burns on hot surfaces

- ▶ Observe the safety instructions (symbol: hot surface) for hot assemblies in the relevant Operating Instructions.
- ▶ Allow hot assemblies to cool before touching.

When work has to be done on hot assemblies:

- ▶ Wear suitable protective clothing.
- ▶ Use heat-resistant tools.
- ▶ Keep disassembled hot components away from electrical components and lines and allow to cool in a protected location.

WARNING: Hazard from hot sample gases

Risk of skin burns from hot sample gases and hot components

At high process temperatures:

- ▶ Attach a warning sign at the sampling point so that it is clearly visible.
- ▶ Keep existing valves and seals closed until they have cooled down.
- ▶ *During installation or maintenance:* Allow affected housing parts and surfaces to cool down before touching.
- ▶ *Before opening gas passages or touching surfaces:* Take suitable protective measures (for example, respiratory protection, heat-resistant protective gloves).

WARNING: Hazard due to self-heating

Fire hazard at the junction box due to short circuits of the lines at too high temperature

Due to self-heating, a temperature of > 60 °C can be reached at the junction box at max. ambient temperature.

When wiring junction boxes:

- ▶ Use cables specified for temperatures > 80 °C.

WARNING: Fire hazard

Fire hazard due to excessive temperature in heated sample gas lines

When laying heated sample gas lines:

- ▶ Observe the enclosed installation instructions.
- ▶ Minimum distance to other lines (for example, electrical lines, gas lines): 2 cm
- ▶ Heated sample gas lines must not touch each other when rolled up.

4.3.5 General safety information on gas measurement technology

WARNING: Danger of accident due to overpressure

Risk of injury due to high pressure

For installation and maintenance:

- ▶ Only use components designed for the process pressure in the application.(see technical documentation).
- ▶ Only carry out device assembly and maintenance when there is no danger from high pressure.

NOTE: Gas analysis system incompatible with liquids

If liquids occur in the internal gas paths, this will usually make the gas analyzer unusable. Liquids can be produced by condensation.

- ▶ Prevent condensation in the sample gas path of the gas analyzer.

If the sample gas contains condensable components:

- ▶ Only operate the gas analyzer in conjunction with an appropriate sample gas conditioning system; see “Designing the sample gas feed”, page 46.
- ▶ Before taking the gas analyzer out of operation, always purge its internal gas path with a neutral gas which does not contain condensable components.

4.3.6 Safety measures against dangerous gases

If the sample gases or auxiliary gases can be dangerous to health:

Protection against dangerous sample gases

WARNING: Health risks through sample gas
If the sample gas can be dangerous to health:
Escaping sample gas can be an acute danger for persons. The concept of the measuring system must contain the required safety measures for health protection. These safety measures must be installed and adhered to. [1]

- ▶ Ensure all persons involved are informed on the sample gas composition as well as know and adhere to the relevant safety measures concerning health protection.
- ▶ Ensure that a leak in the gas path is detected as operational malfunction and relevant safety measures then taken.
- ▶ *If leaks are suspected:* Perform a leak tightness check; see “Leak tightness check of sample gas path”, page 201.
- ▶ *Prior to maintenance work:* Purge the gas paths with a neutral gas until the dangerous gases have been completely eliminated.
- ▶ *If sample gas has escaped:* Take breathing protection precautions.

[1] The operating company is responsible for the composition of the sample gas. The operating company has to ensure the relevant safety measures.

Constructive safety measures (examples)

- ▶ *S710/S711:* Capsule the enclosure in a gas-tight outer enclosure. Purge the outer enclosure with a neutral gas; discharge the purge gas at a safe location.
- ▶ *S715 standard/S720 Ex/S721 Ex:* Purge the enclosure with a neutral gas (see “Purge gas connections (option)”, page 53); discharge the purge gas at a safe location.

Further safety measures (example)

- Attach warning signs to the gas analyzer.
- Attach warning signs at the entry to the operational room.
- Inform persons who can be in the area on risks and required safety measures.

4.3.7 Note for devices with measuring range up to 100% O_2

WARNING: Fire hazard due to high oxygen concentration
Fire hazard as a result of exothermic reaction
When working on the device:

- ▶ Before assembly:
  - Check suitability of the device for the intended application.
  - Check the suitability of the sealing material for the intended application (for example, on the basis of the technical data).
- ▶ Only mount and dismount the device when there is no danger from a high oxygen concentration.
- ▶ *When using oxygen-enriched gases (> 25% by volume) for device calibration and adjustment:* Safely discharge escaping gas.
- ▶ *When using cleaning agents:* Ensure thorough rinsing of cleaned components.
- ▶ Check assemblies with contact with sample gas regularly to ensure these are free from oil, grease and dust.

4.4 Mounting the enclosure

4.4.1 Mounting location, ambient conditions

Inclination

- ▶ Mount the S700 so that the enclosure base is approximately horizontal (for S720 Ex/ S721 Ex: the base of the analyzer enclosure).

Quiet running

- ▶ Select an installation location free from vibration.
- ▶ Protect the S700 from hard shocks.

Temperature

- ▶ Maintain the specified ambient temperature during operation; see “Ambient conditions”, page 241.
- ▶ Avoid exposure to direct sunlight.
- ▶ Do not block the air circulation on the cooling fins of the enclosure.
- ▶ Avoid the effect of extreme heat sources or cooling.
- ▶ Avoid rapid temperature changes.

Humidity

- ▶ Install the gas analyzer in a dry and frost-free place.
- ▶ Maintain the permitted air humidity; see “Ambient conditions”, page 241.
- ▶ Make sure that moisture condensation does not occur – both outside and inside the enclosure.

WARNING: Risk of explosion

- ▶ Observe the application limitations for use in potentially explosive atmospheres; see “The interface converter enables the use of Modbus TCP and remote control via MARC2000.”, page 16.

WARNING: Risk of explosion (only for S715 Ex/S715 Ex CSA)

The tightness of the enclosure of a S715 can be affected by strong heating-up of the enclosure (for example, by direct sunlight). In such a case, the conditions for the use in potentially explosive atmospheres of Zone 2 would no longer be fulfilled.

- ▶ Carefully adhere to the temperature conditions for the S715 Ex in potentially explosive atmospheres (Zone 2).

NOTE: Consequences of incorrect mounting:

- The specified measuring precision will not be achieved.
- Sporadic measurement errors might occur.
- The overall measuring function could be affected.

4.4.2 Enclosure installation

CAUTION: Accident risk through inadequate fastening of the device
- ▶ Consider the device weight specifications when planning the mounting supports.
- ▶ Check the load capacity/condition of the wall/rack on/in which the device is to be installed.

- Weight specifications (mass) see “Enclosure specifications”, page 240.
- Enclosure and mounting dimensions see “Dimensions”, page 238.

S710/S711

▶ Install the enclosure in a standard 19" rack or an appropriate outer housing, in the usual way.

NOTE:
- ▶ Use rack rails that carry the weight of the enclosure.
- ▶ Do not attach the enclosure to the front panel only..

Otherwise the enclosure might be damaged.

If another device is installed above the S700, with an installation depth which is not significantly smaller, then it is a good idea not to mount the instruments directly one above the other, but to leave a vertical gap of at least 1 height unit. This will improve the temperature conditions.

S715

▶ Install the mounting brackets either at top and bottom of the enclosure or at its sides, just as required.
▶ Mount the enclosure on a stable wall or vertical rack.

S720 Ex/S721 Ex

The enclosure comprises three parts (see “Characteristics of the enclosure types”, page 21). Each of these parts can be installed separately from one another as far as the connecting cable allows. The keypad has a magnetic back.

▶ Mount the analyzer unit and the display unit on a solid wall or stable rack.
▶ Place the keypad in an appropriate position.

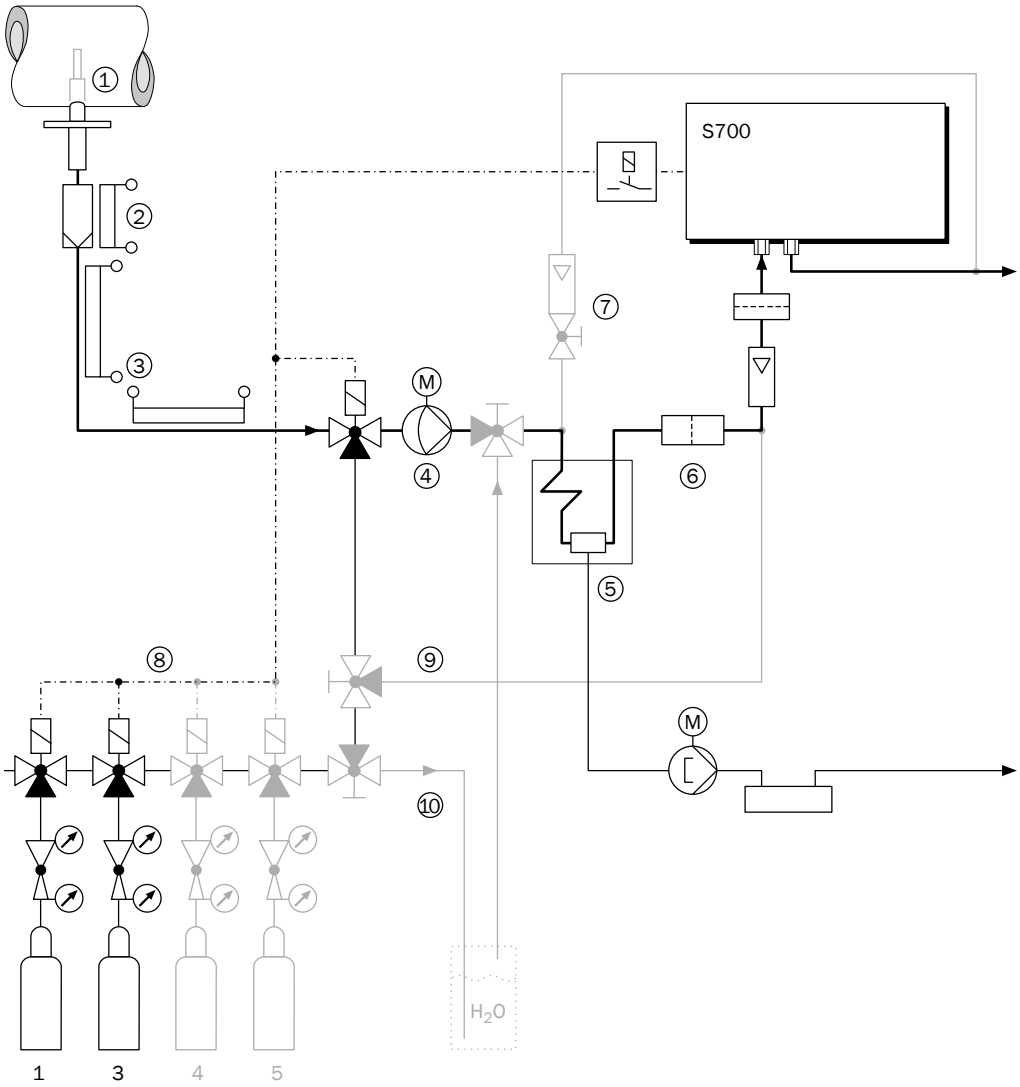
4.5 Sample gas connections

4.5.1 Designing the sample gas feed

In most cases, the gas analyzer is a component of a measuring system. A suitable design of the entire measuring system is required to achieve trouble-free measuring operation, good measuring data, and a minimum of maintenance. Important criteria are, for example, correct choice of the sampling point, appropriate devices for sample gas feed and a careful installation. These items are as essential to the success of measurement as the analyzer itself.

The following diagrams are examples for a proper sample gas feed.

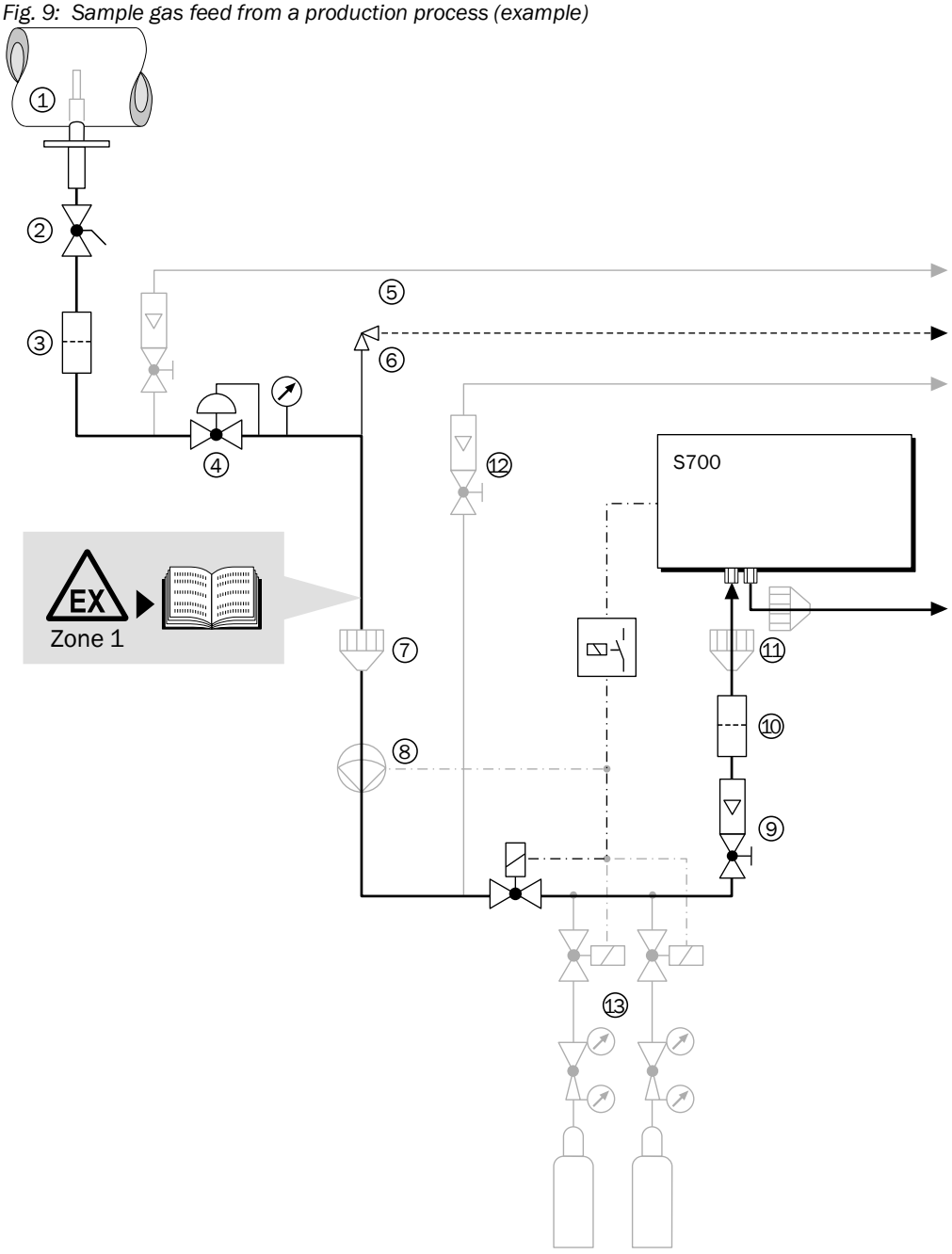
Fig. 8: Sample gas feed from an emission source (example)



If you intend using an NO_X converter to measure the total nitric oxide concentration ($NO+NO_2$) with a NO gas analyzer, please observe the information in Information on using a NO_X converter", (see page 230).

Legend for Fig. 8, page 46-	
1	*Sampling point:* When extracting the sample gas from large containers or large duct cross sections (for example, chimneys), the gas mixture must be homogeneous at the sampling point. If stratification in the gas flow is expected, you should test the entire cross-section of the gas stream to find the best location for the sampling probe. Observe the Operating Instructions of the sampling system.
2	*Dust filter:* Always install a dust filter in the sample gas feed to protect the measuring system against contamination. Even if the sample gas is free of particles, install a dust filter as safety filter to protect the gas analyzer in case of operational malfunctions and defects. – If the sample gas contains condensable components (for example, water vapor - “wet gas”), the filter needs to be heated. Gas sampling probes with integrated filters at the tip of the sampling tube are also available so that the filter heating is not needed.
3	*Heated sample gas line:* Use a heated sample gas line if the temperature around the sample gas line may fall below the freezing point or if the temperature in the sample gas line may fall below the dew point of sample gas components. This will prevent the sample gas line from being blocked by ice or condensate.
4	*Gas pump:* If a separate gas pump is installed, the power supply of this pump should be controlled via a switching output of the S700 (see “Available switching functions”, page 121). Thus, the gas pump automatically remains switched off as long as the gas analyzer is not ready for operation.
5	*Sample gas cooler:* The components in the sample gas must not fall below their dew point in the gas analyzer, as condensate in the gas paths makes the gas analyzer unusable. A sample gas cooler can be used to prevent this effect (detailed information, see “Information on using a sample gas cooler”, page 228).
6	*Fine dust filter*: Always install a fine dust filter in front of the sample gas inlet of the gas analyzer - even if another dust filter is already fitted in the sample gas path. This will protect the optical system of the gas analyzer against immediate contamination in case of operational malfunctions (for example, when the other dust filter fails to work) and against slow “hidden” contamination (for example, caused by valve abrasion of pumps).
7	*Analyzer bypass* If required): Increases the sample gas volume flow from the sampling point and thus reduces the measuring delay (lag time).
8	*Calibration gases:* During a calibration, calibration gases must be fed into the gas analyzer. In most cases, the calibration gases should flow into the analyzer under the same conditions as the sample gas – which means, flowing through the complete gas conditioning system. However, for some applications, special criteria must be observed; see “Special notes”, page 222. Calibration gas feed can be automatically controlled by setting up appropriate switching outputs; see “Available switching functions”, page 121. This option is the basis for fully-automatic calibrations (see “Requirements for automatic calibrations”, page 156) and can also simplify manual calibrations (see “Automatic calibrations”, page 156).
9	*Bypass for sample gas cooler:* Useful for zero point calibration of H_2O (see “Calibration of measuring component H_2O”, page 174) and for calibration of an H_2O cross-sensitivity compensation (see “Calibration of cross-sensitivity compensations (option)”, page 177).
10	*Bypass for H_2O calibration:* Useful for an H_2O sensitivity calibration because the test gas must be created “by hand” (see “Calibration of measuring component H_2O”, page 174).

Fig. 9: Sample gas feed from a production process (example)



Legend for Fig. 9, page 48-	
1	*Sampling point:* When extracting sample gas from large containers or large duct cross-sections, the sample gas mixture must be homogeneous at the sampling point. If stratification in the gas flow is expected, you should test the entire cross-section of the gas stream to find the best location for the sampling probe. Observe the Operating Instructions of the sampling system.
2	*Shut-off valve:* Useful to isolate the analysis system from the industrial process when necessary.
3	*Dust:* Always install a dust filter in the sample gas feed to protect the measuring system against contamination. Even if the sample gas is free of particles, install a dust filter as safety filter to protect the gas analyzer in case of operational malfunctions and defects.
4	*Pressure reducer:* Adjusts the sample gas pressure to the requirements of the gas analyzer.
5	*Slipstream bypass* (if required): Increases the sample gas volume flow from the sampling point to the pressure reducer and thus reduces the measuring delay (lag time).
6	*Bypass valve* or bursting disk: Protects the gas analyzer from high pressure if the slipstream pressure reducer fails.
7	*Flame arrester in the sample gas flow:* Prevents inflamed gas from flowing into the gas analyzer or that ignited gas from the gas analyzer endangers the process.
8	*Sample gas pump:* Feeds the sample gas to the gas analyzer. This is required if the sample gas pressure is not sufficient. – Please observe to the following notes: – If dust or particles could pass through the pump (for example, as a result of valve abrasion), you should install an additional particle filter after the pump. – The power supply of this pump should be controlled via a switching output; see “Available switching functions”, page 121. Thus, the gas pump automatically remains switched off as long as the gas analyzer is not ready for operation. – When the S700 has a gas pump fitted, (see “Optional equipment”, page 32), use the internal pump capacity setting to set the desired volume flow; see “Setting the gas pump capacity”, page 137.
9	*Control valve:* To set the correct sample gas volume flow. (Not needed when the S700 has a fitted gas pump; see “Setting the gas pump capacity”, page 137).
10	*Fine dust filter*: Always install a fine dust filter in front of the sample gas inlet of the S700 – even if another dust filter is already fitted in the sample gas path. This will protect the optical system of the gas analyzer against immediate contamination in case of operational malfunctions (for example, when the other dust filter fails to work) and against slow “hidden” contamination (for example, caused by valve abrasion of pumps).
11	*Flame arresters on the gas analyzer:* Prevent ignited gas from flowing from the gas analyzer back to the process. This might be mandatory in potentially explosive atmospheres. [1]
12	*Analyzer bypass* (if required): Increases the sample gas volume flow to the gas analyzer. Install an analyzer bypass if a quick response time is required.
13	*Supply of calibration gases* see page 47.

[1] The enclosure type S720 Ex/S721 Ex has fitted flame arresters.

4.5.2 Possible hazards due to the sample gas

WARNING: Hazardous sample gas

Health hazard due to escaping sample gas

When using toxic, flammable, hot and/or corrosive sample gases:

- ▶ Inform the operator about the gases used (see respective Safety Data Sheet) as well as the appropriate safety measures for health protection (for example, suitable protective clothing).
- ▶ Safe handling of the sample gas is the responsibility of the operator, for example:
  - If necessary, install gas detectors (for example, for odorless gases).
  - If necessary, provide shut-off or check valve.
  - *If leakage is suspected:* Check gas path for leaks.
  - Use suitable sealing material (depending on application).
  - *If reverse flow safeguards are fitted:* Check these are functioning properly.
- ▶ *Before opening gas paths:* Take suitable safety measures (for example, stop sample gas feed, purge gas paths with inert gas, breathing protection, protective clothing).
- ▶ *Before opening the enclosure:* Interrupt the gas supply. Ensure sufficient air exchange within the analyzer. The required air exchange depends on the application (hazard potential of the sample gas) and on the configuration (implementation of further safety measures). Purge gas feed can remain open.

On installations with toxic gases, overpressure and high temperatures:

- ▶ Only fit/remove components fitted on the duct when the installation is at a standstill.

WARNING: Hazard through sample gas and its residues

Hazard through contact with sample gas dangerous to health

Before opening device components with sample gas contact or disassembling the device, observe:

- ▶ The enclosure can be contaminated with sample gas dangerous to health when the gas path has a leak.
- ▶ Take suitable protective measures (for example, Safety Data Sheet, breathing protection, gloves, clothes (acid resistant as necessary), suctioning off).
- ▶ *In case of contact of skin or eyes with contaminated part:* Follow instructions of the respective Safety Data Sheet and consult a doctor.
- ▶ Observe cleaning instructions; contact Endress+Hauser Customer Service when necessary.
- ▶ Interrupt gas supply to the unit; exception: purge gas supply (if present).
- ▶ Remove sample gas residues: Purge all parts carrying sample gas with inert gas for a sufficiently long time (depending on the application).
- ▶ Remove solid and liquid residues.

WARNING: Further hazards through sample gas

- ▶ see “Heat safety instructions”, page 42
- ▶ see “General safety information on gas measurement technology”, page 42
- ▶ see “Safety measures against dangerous gases”, page 43
- ▶ see “Note for devices with measuring range up to 100% O_2”, page 43
- ▶ see “Possible application limitations with the sample gas”, page 51

4.5.3 Possible application limitations with the sample gas

WARNING: Hazardous sample gases

Fire and injury hazard when measuring combustible, explosive gases

- Only introduce ignitable or explosive sample gases when the following special measures are taken: see “Characteristics of the enclosure types”, page 21.
- The application restrictions of the enclosure types must be observed when the limit of 25% of the lower explosion limit is exceeded: see “Characteristics of the enclosure types”, page 21.

WARNING: Risks in potentially explosive atmospheres

When the S700 is used in a potentially explosive atmosphere:

- Observe application limitations and application requirements.
  - see “The interface converter enables the use of Modbus TCP and remote control via MARC2000.”, page 16
  - see “Characteristics of the enclosure types”, page 21
- *Before the first start-up:* Check all installed sample gas inlets and outlets with 150% of the respective maximum line pressure for leak tightness and tightness.

NOTE: Risk of damage

- Check whether the sample gas can chemically attack the sample gas path materials; see “Materials with sample gas contact”, page 248.

4.5.4 Connecting the sample gas inlet (SAMPLE)

Standard versions of the S700 have just one internal gas path to which all analyzer modules are connected. Special versions can have 2 or 3 internal gas paths; see “Connecting the additional gas paths (REF./REF. OUT – optional)”, page 52.

- ▶ Feed the sample gas via the SAMPLE connection into the S700.
- ▶ Observe the operating conditions for the sample gas; see “Measuring characteristics”, page 243.

NOTE: Risk of damage

- ▶ Prevent any liquids entering the sample gas path of the gas analyzer.
- ▶ Prevent condensation in the sample gas path of the gas analyzer. If the sample gas contains condensable components, only operate the gas analyzer in conjunction with an appropriate gas conditioning system; see “Designing the sample gas feed”, page 46.
- ▶ Always install an external fine dust filter in the sample gas feed to protect the gas analyzer against contamination.[1]

[1] Even if the sample gas is free of particles, install a dust filter as safety filter to protect the gas analyzer in case of operational malfunctions and defects.

4.5.5 Connecting the sample gas outlet (OUTLET)

- ▶ Connect the OUTLET fitting to a suitable collection point (e. g. exhaust gas channel).

CAUTION: Risk of incorrect measurements

The sample gas may not enter the enclosure.

- ▶ Make sure that the sample gas outlet is discharged properly.

No strong pressure fluctuations may occur at the sample gas outlet.

- ▶ Make sure the sample gas can flow out “freely”.

The pressure at the sample gas outlet should not be increased significantly. Installing a throttle valve at the sample gas outlet is not permissible.

- ▶ Only install a control valve to set the volume flow before the sample gas inlet.

Otherwise significant measurement errors might occur.

4.5.6 Connecting the additional gas paths (REF./REF. OUT – optional)

Only applies to analyzers with REF. and/or REF. OUT gas connections

Versions equipped with a REF. and/or REF. OUT gas connection have 2 or 3 separate internal gas paths (special version). The internal gas paths may have a common outlet or separate outlets. The actual gas path configuration is specified in the individual information delivered with the gas analyzer.

- ▶ Use the REF. connection (if existing) to feed the span gas or the second sample gas. Maintain the same operating conditions as for the SAMPLE connection (see “Connecting the sample gas inlet (SAMPLE)”, page 52).
- ▶ Connect the REF. OUT fitting (if existing) to a suitable collection point. Maintain the same operating conditions as for the OUTLET connection (see “Connecting the sample gas outlet (OUTLET)”).
- ▶ Observe any delivered information on the individual gas analyzer with higher priority.

During a zero point calibration, the span gas must be fed as “zero gas” via the sample gas path. It can be advantageous to install an appropriate connection line.

4.6 Purge gas connections (option)

Only applies to analyzers with PURGE IN/PURGE OUT gas connections

S710/S711

▶ *If required:* Feed purge gas via the connection PURGE IN into the enclosure (operating conditions at user's choice).

S715 standard

▶ *If required:* Feed purge gas through the enclosure via the connections PURGE IN and PURGE OUT.

- The enclosure of the S715 Ex is “vapor-proof” according to EN 60079. (Criterion: It takes more than 90 seconds for the partial vacuum in a closed enclosure to increase from 3 mbar to 1.5 mbar.)
- If the S715 Ex is used in a potentially explosive atmosphere (Zone 2), it must be possible to open or close the purge gas connections during a leak tightness check of the enclosure (see “Leak tightness check for the enclosure S715 Ex”, page 203).

CAUTION: Safety risks
▶ Seal unused purge gas connections jet-water tight.
Otherwise the specified enclosure protection is not maintained.

S720 Ex/S721 Ex

▶ *If required:* Feed purge gas through the analyzer enclosure via the connections PURGE IN and PURGE OUT.

CAUTION: Risks in potentially explosive atmospheres
▶ Use steel tubing for all the purge gas lines when the related requirements apply; see “Possible application limitations with the sample gas”, page 51.
▶ Set-up the purge gas feed in such a way that the purge gas pressure does not exceed 100 mbar (referred to the ATEX certification.
▶ Close unused purge gas connections either flameproof or replace these with closure claps certified for potentially explosive atmospheres (thread: ISO 228/1 - G 1/4"). Apply “Loctite 243” adhesive to the threads and sealing surfaces.

4.7 Enclosure venting (option)

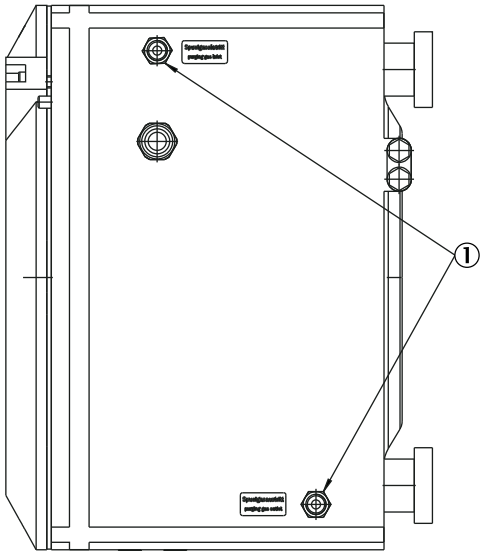
S720 Ex/S721 Ex

Installing a flame arrester achieves enclosure ventilation.

The flame arrester used corresponds to the flame arrester fitted in the sample gas paths (in/out). A 50 mm tube (4/2 mm outer/inner diameter) is additionally fitted from the interior to the flame arrester.

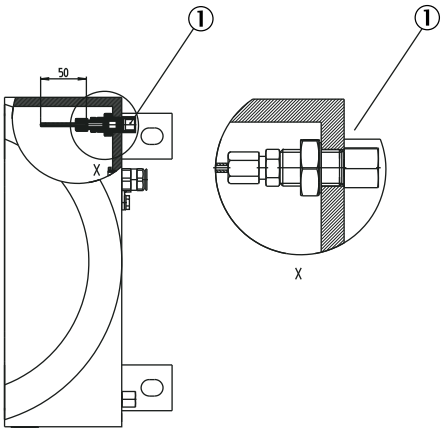
Operating specifications of the S700 remain unchanged.

Fig. 10: Fitting options



Legend	
1	Flame arrester

Fig. 11: Fitting details



▶ Insert position ① with Loctite 243

4.8 Opening and closing the enclosure

4.8.1 Safety precautions before opening the enclosure

WARNING: Health risks during maintenance work

If the sample gas can be dangerous to health: Escaping sample gas can be an acute danger for persons.

Before opening gas paths (for example, to clean the filter):

- ▶ Purge gas paths with a neutral gas until the dangerous gases have been completely eliminated.
- ▶ Take breathing protection precautions as necessary for safety.

WARNING: Health risks (information)

- ▶ Observe the safety information on health protection; see “Health protection, decontamination”, page 196.

WARNING: Accidents risks in special cases

- When the S700 measures toxic, dangerous or combustible gases;
- When the S700 is located in a potentially explosive atmosphere;
- When it is suspected that the internal gas paths have a leak:

Perform the following measures before opening the enclosure:

1 Shut off any gas feed to the S700, except for the purge gas feed (if existing).
2 Switch off the power supply to the S700 at an external point.
3 *In potentially explosive atmospheres:* Disconnect the S700 from all external voltages (for example, signal lines). Exception: Connections to intrinsically safe power circuits can remain connected.
4 *For the S720 Ex/S721 Ex:* Wait for the minimum waiting time specified on the analyzer unit to elapse.
5 *If an enclosure purging is installed:* Wait an appropriate time for the enclosure is completely purged with inert gas.
6 If necessary, take protective measures against escaping gases (for example, breathing protection, suctioning off).
7 As soon as the enclosure is opened, the specified enclosure protection and the related explosion protection is no longer valid. Observe all related safety regulations valid for your location.
8 Only open the enclosure when it is truly safe to do so.
9 It must be ensured that no explosive atmosphere is present when the enclosure is open.

NOTE:

Electrostatic voltage can damage or destroy electronic components.

- ▶ *Before touching electrical connections and internal components:* Earth your body and tools used to discharge electrostatic charges.

Recommended method:

- ▶ *If the power connection including the protective conductor is installed:* Touch a blank metal part of the enclosure.
- ▶ *Otherwise:* Touch an “external” blank metal surface which is connected to the protective conductor or has safe contact to earthing.

4.8.2 Opening the enclosure

- For the S715, S720 Ex and S721 Ex, the enclosure has to be opened to connect electrical connections.
- The enclosure of the S710/S711 does not need to be opened for installation work.

WARNING: Health/accident risks

▶ Observe the safety information on opening the enclosure; see “Safety precautions before opening the enclosure”, page 55.

S715

1. Loosen both screws of the relevant front door (suitable wrench in scope of delivery).
2 Swing the front door to the left.

S720 Ex/S721 Ex

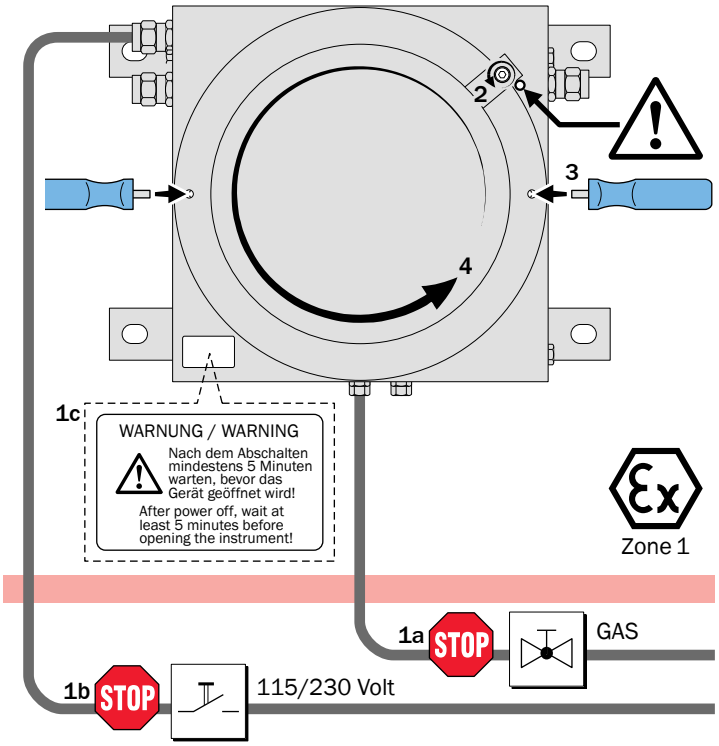
CAUTION: Risk of personal injury

- A pin protrudes from the enclosure at the cover's edge.
- The weight of the front cover is approx. 5 kg (11 lb.).

▶ Wear slip-safe hand gloves and safety shoes when opening the front cover.

1. Loosen the fixing screw on the front cover of the analyzer unit; see Fig. 12.
2 Insert the tool aids into the front cover holes.
3 Loosen the front cover (max. 2 rotations). Remove the tool aids.
4 Unscrew the front cover by hand.

Fig. 12: Opening the analyzer enclosure for S720 Ex/S721 Ex



4.8.3 Closing the enclosure

WARNING: Explosion/Health risk
▶ Keep the enclosure completely closed during operation.
Otherwise the specified explosion protection or enclosure protection is not ensured.

S715

▶ Close the front doors jet-water tight (tighten the front screws) before starting-up the analyzer.
▶ Also close all other enclosure openings jet-water tight.
▶ Close the cable inlets jet-water tight when the cable installation has been made.
▶ Close off all unused cable inlets; see “Correct use of the cable inlets”, page 58.

S715 Ex/S715 Ex CSA additionally (in potentially explosive atmospheres):

▶ *If the enclosure has been opened:* Perform a leak test; see “Leak tightness check for the enclosure S715 Ex”, page 203.

S720 Ex/S721 Ex

▶ Tightly close the front covers of both enclosure units.
▶ Fix the enclosure cover of the analyzer enclosure by tightened the fixing screw.
▶ Close-off any cable inlets used so that these are flameproof.
▶ Close-off unused cable inlets properly; see “Correct use of the cable inlets”, page 58.

4.9 Cable installation (S715/S720 Ex/S721 Ex)

4.9.1 Suitable cables for potentially explosive atmospheres

WARNING: Risk of explosion through wrong cable material
In potentially explosive atmospheres:
- ▶ Only use cables for the electrical connections which meet the requirements of standard EN 60079-14.

EN 60079-14 states criteria for:
- Geometry
- Materials
- Gas-tightness, vapor tightness
- Resistance against water and water vapor
- Disruptive strength

4.9.2 Correct use of the cable inlets

WARNING: Risk of explosion

Permitted cable diameter:
- ▶ Only use cables suitable for the cable inlets:
  - *S715:* Outer diameter of the cable = 7 … 12 mm.
  - *S720 Ex/S721 Ex:* Outer diameter of the cable = 7 … 12 mm, depending on the design of the enclosure.

Cable inlets:
- ▶ *S715:* Before start-up in a potentially explosive atmosphere, close all cable inlets “vapor-proof”.
- ▶ *S720 Ex/S721 Ex:* Before start-up in a hazardous area, replace unused cable inlets with Ex d sealing plugs (M20x1.5). Secure the sealing plugs with “Loctite 243”.
- ▶ Seal unused cable inlets “flame-tight” (nearly gas-tight), either with a sealing plug or by replacing the cable gland with a closing cap.
  - *Sealing plugs:* Select to match the allowable cable diameter and fit instead of a cable.
  - *Closure caps:* Select closure caps with thread M20x1.5 specified for use in potentially explosive atmospheres. Apply “Loctite 243” adhesive on all threads and sealing surfaces.

The cable inlets are subject of the ATEX certification.
- ▶ *If the device is used in a potentially explosive atmosphere:* Do not replace the cable inlets with cable inlets of a different type.

4.9.3 Correct installation of cables

S715 Ex/S715 Ex CSA

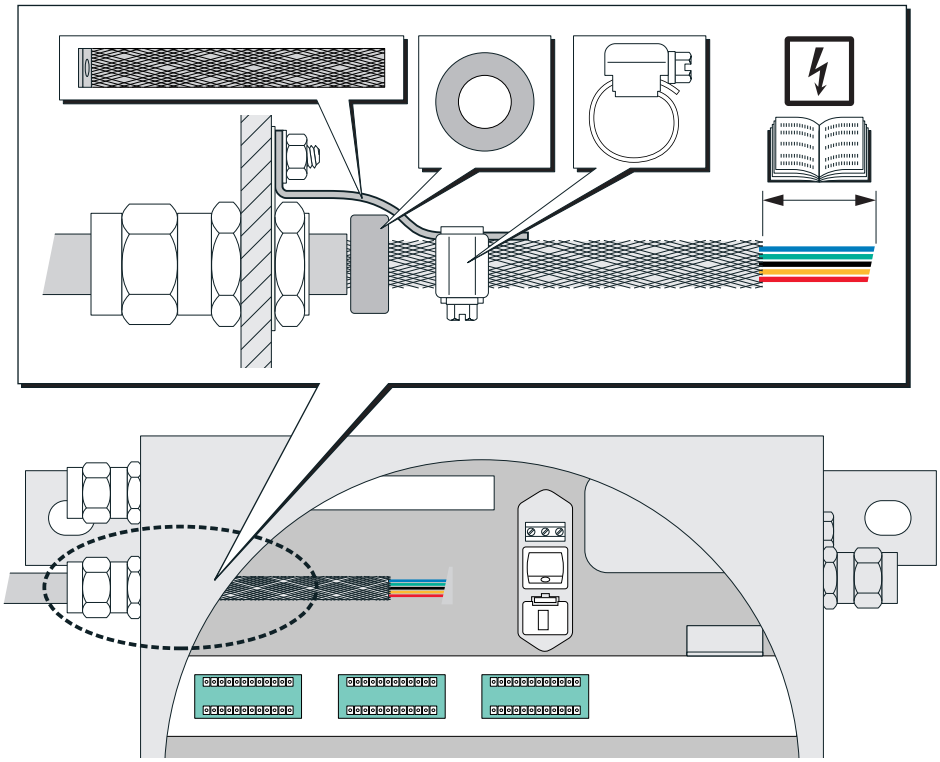
- *In a potentially explosive atmosphere (Zone 2):* Install all connected cables “fixed”, i.e. fasten the cables along the whole length.

S720 Ex/S721 Ex

- *In a potentially explosive atmosphere:* Install all connected cables “fixed”, i.e. fasten the cables along the whole length.
- *To reach the specified interference immunity:* Install the signal cables inside the enclosure as follows (see Fig. 13):

1. Remove the outer insulation shield from the signal cable between cable end and cable inlet; however, leave the metal cable shield on the cable, as far as possible – remove the cable shield only where it is required to connect the cable ends.
2. Push a ferrite ring (in scope of delivery) over the signal cable.
3. Connect the supplied wired metal stripe to the threaded bolt next to the cable gland.
4. Use the supplied metal hose clamp to connect the wired metal strip to the cable shield. Use a metal hose clamp (in scope of delivery).
   - Make a good electrical connection.
   - Use the hose clamp also to keep the ferrite ring close to the cable gland.

Fig. 13: Installation of signal cables for S720 Ex/S721 Ex



4.10 Power connection

4.10.1 Safety information for power connection

Electrical safety through lines with correct rating

WARNING: Endangerment of electrical safety through incorrect measurement of the power cable
When a removable power cable is used, electrical accidents can occur when the specifications are not fully observed.
- ▶ *If a removable power cable has to be replaced:* Observe the exact specifications (→ Supplementary Operating Instructions of the enclosure).

Grounding the devices

CAUTION: Device damage through incorrect or missing grounding
- ▶ Ensure that the protective grounding to the affected devices or lines is effective in accordance with EN 61010-1 during installation and maintenance work.

CAUTION: Health risk
- ▶ Only connect the device to a main power supply with a functional protective conductor (protective earth, PE).
- ▶ Only start the device when a correct protective conductor connection is installed.
- ▶ Never interrupt a protective conductor connection (yellow-green cable) inside or outside the enclosure.

Otherwise electric safety is not ensured.

Correct power voltage

CAUTION: Damage or malfunction by wrong power supply
The power voltage must match the power voltage setting of the S700. The power voltage frequency must match the data on the S700 type plate.
- – If the power voltage is too high, then the S700 can severely be damaged. The S700 can be dangerous when operated in such a damaged state.
- – If the power voltage is too low, the S700 will not work correctly.

- ▶ Ensure the power voltage setting matches the existing power voltage; see Fig. 14, page 62, Fig. 15, page 63-, Fig. 16, page 64-.
- ▶ Adapt the setting as required; see “Adapting to power voltage”, page 209.

Electrical safety through disconnector switch

For information see “Installing a separate disconnector switch”, page 61.

The internal power switch (S715/S720 Ex/S721 Ex) may only be used for Service work outside potentially explosive atmospheres.

WARNING: Further information on electrical safety
- ▶ see “Safety instructions for electrical safety”, page 41

4.10.2 Using a separate power fuse

▶ In addition, install an individual external power fuse for the S700. Fuse rating: T 10 A.

After switching on, for a very short time, the S700 draws a much higher current than specified for operation (approx. 40 A for approx. 5 ms). Therefore, external fuses for the S700 power supply should have a slow-blow or delay-action characteristic.

4.10.3 Installing a separate disconnector switch

WARNING: Endangerment of electrical safety through not switching the power supply off during installation and maintenance work

An electrical accident can occur during installation and maintenance work when the power supply to the device and/or lines is not switched off using a disconnector switch/ circuit breaker.

- ▶ Before starting the work, ensure the power supply can be switched off using a power isolating switch/circuit breaker in accordance with DIN EN 61010.
- ▶ Make sure the disconnector switch is easily accessible.
- ▶ *If it is not possible or difficult to reach the disconnector switch after installation of the device connection:* Install an additional disconnecting device.
- ▶ The power supply may only be activated again by personnel carrying out the work (after the end of the installation work or for test purposes). Observe the valid safety regulations.

The internal power switch (S715/S720 Ex/S721 Ex) may only be used for Service work outside potentially explosive atmospheres.

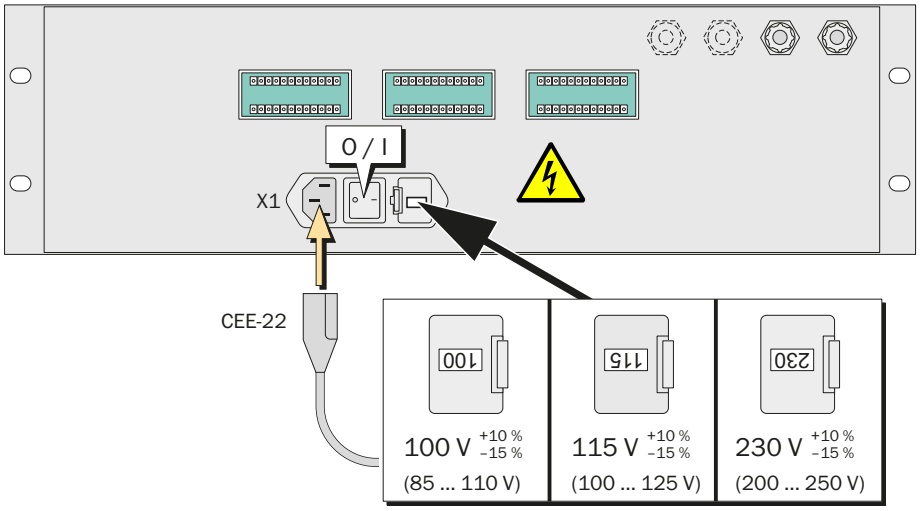
4.10.4 Connecting the power cable

S710/S711

To ensure that the device is not unintentionally starting up:
▶ Ensure that the main power switch is turned off (“0” visible see Fig. 14).

1. Check that the device is set to the correct power voltage (100/115/230 V see Fig. 14). If required, adapt the setting to your mains power voltage; see “Adapting to power voltage”, page 209.
2 Connect the power cable to the built-in plug on the rear panel (standard CEE-22 plug see Fig. 14).
3 Connect the power cable to an appropriate power supply (safety information see “Safety information for power connection”, page 60).

Fig. 14: S710/S711 – power connection, main power switch, position of the signal connections



WARNING: Endangerment of electrical safety through incorrect measurement of the power cable
When a removable power cable is used, electrical accidents can occur when the specifications are not fully observed.
▶ *If a removable power cable has to be replaced:* Observe the exact specifications; see “Electrical data”, page 242.

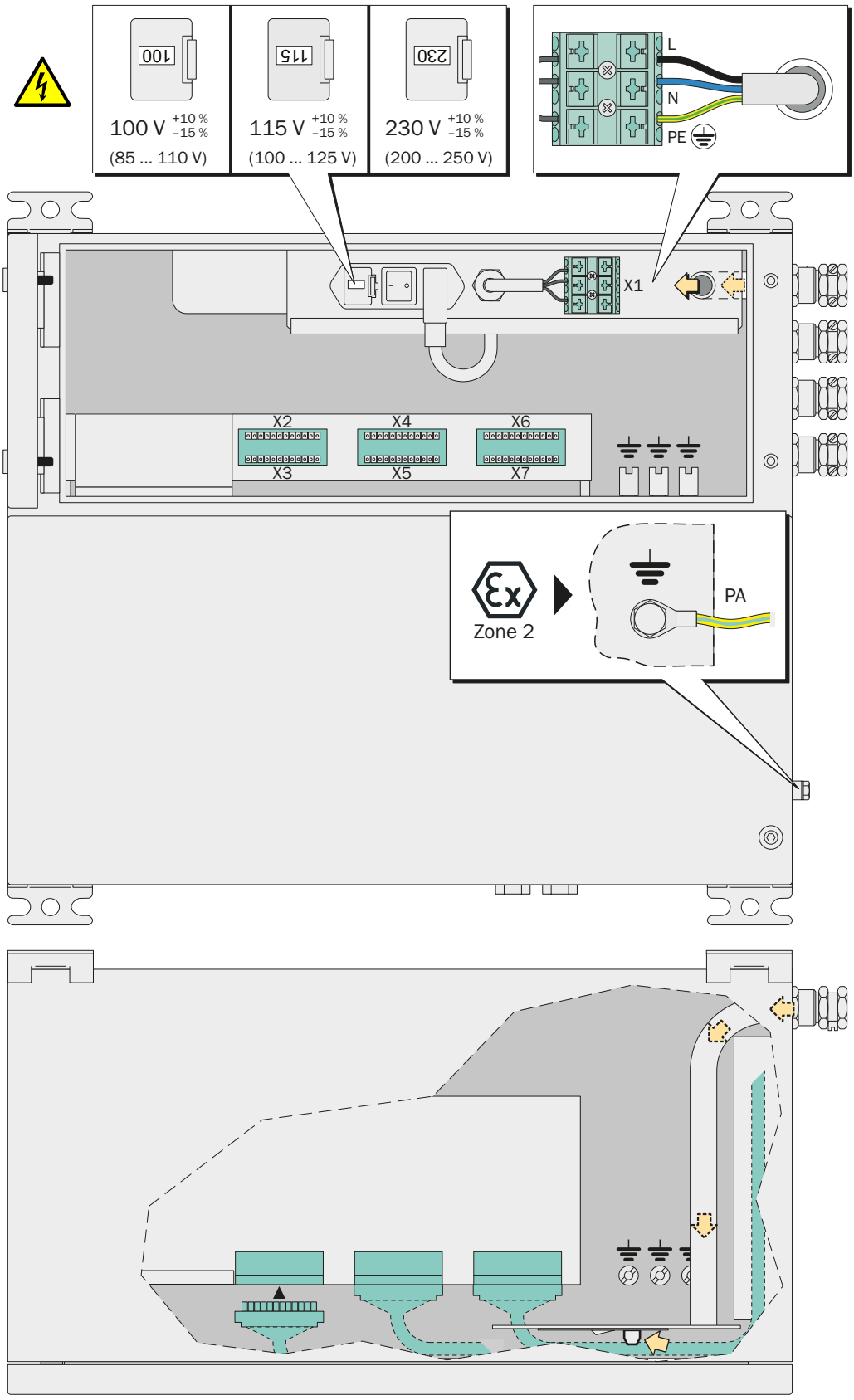
S715

WARNING: Risk of explosion
In potentially explosive atmospheres:
▶ Connect the PA connection on the outside the enclosure to the same electrical potential as the internal PE connection.
▶ Do not switch-on the mains power as long as the enclosure is open.

WARNING: Health risk
▶ *Before installing the power cable:* Make sure the external main power supply is switched off.

1. Open the top part of the enclosure; see “Opening the enclosure”, page 56.
2 Check that the device is set to the correct power voltage: see “Adapting to power voltage”.
3 Put the power cable through the upper cable gland.
4 Connect the power cable to the power connection terminals (PE = Protective Earth, N = Neutral, L = Live).
5 Close the cable gland on the cable.

Fig. 15: S715 – power connection, position of the signal connections



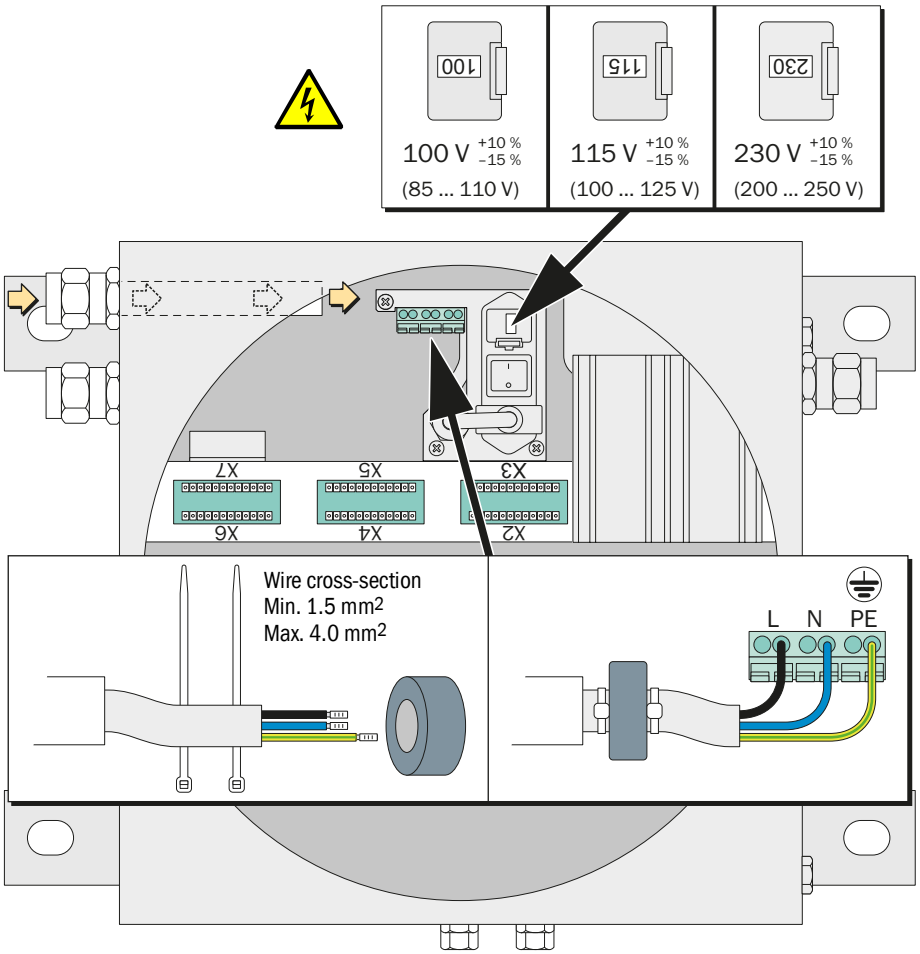
S720 Ex/S721 Ex

WARNING: Risk of explosion
▶ *In potentially explosive atmospheres:* Do not switch on the main power supply as long as the enclosure is open.

WARNING: Health risk
▶ *Before installing the power cable:* Make sure the external main power supply is switched off.

1. Open the analyzer unit; see “Opening and closing the enclosure”, page 55.
2 Check for which power voltage the device is equipped; see “Adapting to power voltage”, page 209.
3 Put the power cable in through a cable gland; see “Cable installation (S715/S720 Ex/S721 Ex)”, page 58.
4 Inside the enclosure, put the provided ferrite ring onto the power cable and fix it with cable straps; see Fig. 16.
5 Connect the power cable to the power connection terminals (PE = Protective Earth, N = Neutral, L = Live).
6 Close the cable inlet until it makes a “flame-tight” (nearly gas-tight) fit around the cable.

Fig. 16: S720 Ex/S721 Ex – power connection and position of the signal connections



4.11 Signal connections

4.11.1 Type of terminal connections

12-pole plug connectors are used for the signal connections. The supplied counterparts are equipped with screw terminals and lock-in housings.

Each S700 connector has one blocked recess as a mechanical code for the connection. The matching edge must be removed on the counterpart (see Fig. 17).

Fig. 17: S700 plug connector

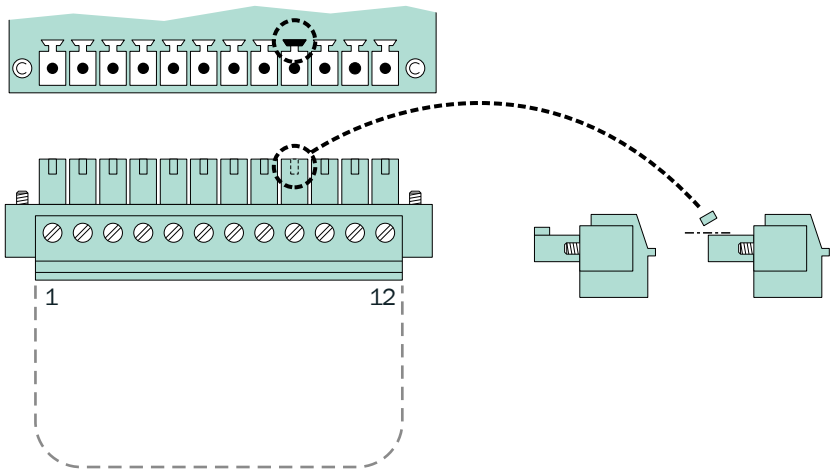


Table 8: Mechanical coding of the plug connectors

Plug connector	X2	X3	X4	X5	X6	X7
Coding on pin no.	2	3	4	5	6	7

NOTE:

Before signal connections are established (also with plug connections):

▶ Disconnect the S700 and connected devices from the power supply (switch-off).

Otherwise the internal electronics could be damaged.

All exterior power circuits conduct signal low voltages < 50 V DC.

The option “intrinsically-safe measured value outputs” has additional screw terminals for the measured value outputs; see “Intrinsically-safe measured value outputs”, page 74.

4.11.2 Suitable signal cables

All exterior power circuits only conduct signal low voltages <50V DC.

- ▶ Only use cable material meeting the following requirements is used for signal lines and control lines:
  - AWG22 (or better)
  - Insulating strength > 520 V
- ▶ Use shielded cables for all signal lines. The high-frequency impedance of the shield must be low.
- ▶ Connect only one side of the cable shield to GND/enclosure. When possible, make a short connection with a broad contact.

▶ Observe the shielding concept of the host system (if existing).

NOTE:
▶ Use suitable cables only. Install all the cables properly.
Otherwise the specified EMC protection is not guaranteed, and sporadic and inexplicable functional problems might occur.

WARNING: Endangerment of electrical safety through wrong cables
If external heating lines are powered with power voltage:
▶ Use cable material with a conductor cross-section of at least 3 x 1 mm².

4.11.3 Maximum load of the signal connections

Maximum switching contact load

Table 9: Maximum permitted load for each relay switch contact [1]

Product version		AC voltage[2]	DC voltage	Current[2]
Standard		max. 30 VAC	max. 48 V DC	max. 500 mA
CSA version[3]	either[4]	max. 30 VAC	max. 48 V DC	max. 50 mA
	or[4]	max. 15 VAC	max. 24 V DC	max. 200 mA
	or[4]	max. 12 VAC	max. 18 V DC	max. 500 mA

[1] All voltage values referenced to GND/enclosure
[2] Effective value.
[3] Possible voltage/current combinations in CSA standard range or within the framework of a CSA certification. Identification of a CSA version, see “Product identification”, page 19.
[4] At user’s choice

NOTE:
Only use discharging diodes to connect inductive loads (for example, relays, solenoid valves).
▶ *For inductive loads:* Check whether discharging diodes are fitted.
▶ *If this is not the case:* Install external discharging diodes; see “Anti-inductive protection for the signal connections”, page 67.

Maximum input voltage

- Maximum peak voltages on digital interfaces: ±15 V
- Highest permitted voltage at the optocoupler inputs:
  - Control voltage: ±24 V DC
  - Peak voltage: 48 V (peak)
- Voltage peaks on the other signal connections: ±48 V (peak).

NOTE:
Any voltage greater than 48 V - even short “peaks” - could damage internal components.
▶ Keep external voltages and voltage peaks away from the signal connections.

4.11.4 Outputs for signal voltage (auxiliary voltage)

An auxiliary voltage of 24 V DC is available on the “24V1” and “24V2” connector pins which can be used as voltage supply for external low-powered devices (for example, relays).

A common internal voltage source supplies both outputs; the allowable amperage is 1 A (24V1 + 24V2). An internal fusible cutout protects against overloads; (see “Internal fuses”, page 210).

4.11.5 Anti-inductive protection for the signal connections

Internal EMC filters

There is an EMC filter between the internal electronics and each S700 signal connection. This also applies for the measured value outputs and the digital interfaces; only the mass connections (GND) do not have an EMC filter. These internal EMC filters must be protected against high voltages.

Risks caused by inductive loads

Devices, whose internal electric circuits are equipped with coils or windings with iron core, can produce a countervoltage which can be very much larger than the operating voltage. Such devices are, for example, solenoid valves, pumps, electrical bells, relays, and electrical motors. The induced voltage of such devices can immediately destroy an internal EMC filter. In many cases, a defective EMC filter can short-circuit the signal connection to ground (GND).

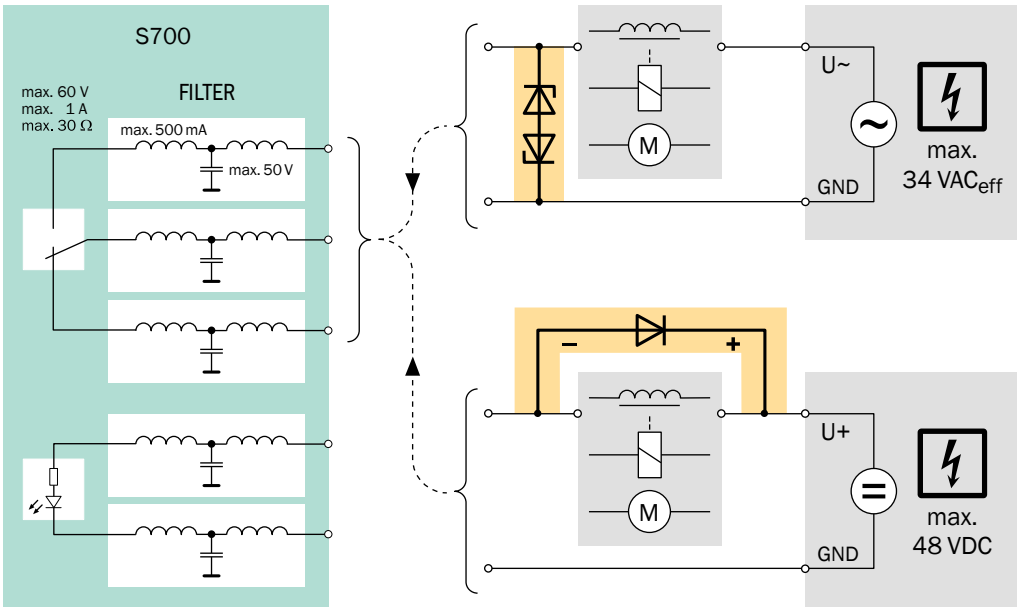
Protective measures

NOTE:

- *If the connected devices can create induced voltages and are not fitted with discharging diodes:* Install one or two “discharging diodes” on each inductive load to discharge any induced voltages (see Fig. 18).

Otherwise internal EMC filters can be destroyed, which will make the entire internal electronics board unusable.

Fig. 18: Connecting inductive loads



4.12 Measured value outputs

Function

The S700 has four measured value outputs to output of the measured values of the measuring components (OUT1 ... OUT4 see Fig. 19, page 69).

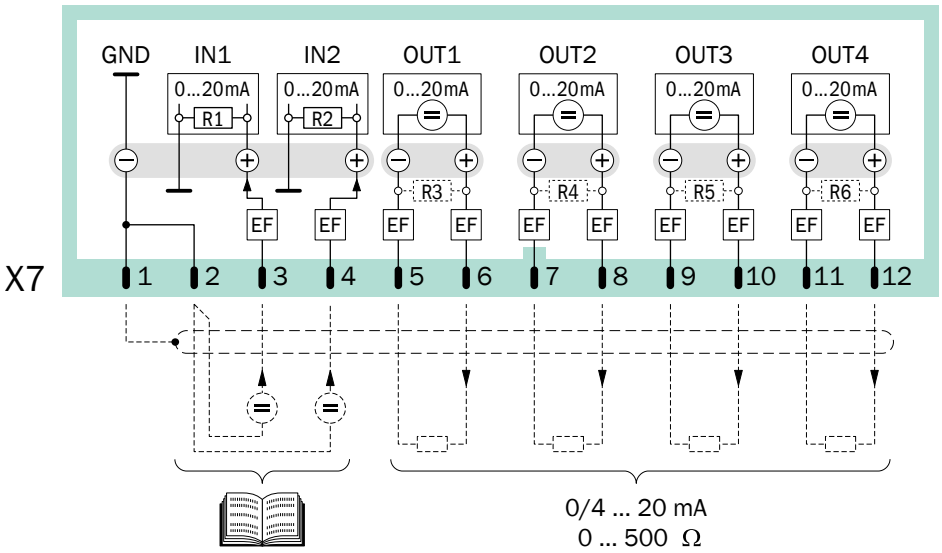
- *Operation:* The S700 measures in a quasi-continuous mode. New measured values are generated approximately every 0.5 ... 20 seconds (depending on the individual application and the number of measuring components).
- *Measuring components:* Which measuring component is output on which measured value output can be set; see “Assigning measuring components”, page 116. The assignment corresponds to the sequence on the display set at the factory; see “Measuring displays”, page 97.
  Exception: For certain sampling point selector configurations (see “Sampling point selector (option)”, page 142), each measured value output automatically represents one of the sampling points; detailed information see “Special functions for certain sampling point configurations”, page 116.
- *Output ranges:* Each measured value output can signal the measured value in two different output ranges (setting see “Setting-up the output ranges”, page 117; selection of the current output range see “Selecting the output ranges”, page 118). The working output range can be indicated by a status output; see “Available switching functions”, page 121.
- *Function during a calibration:* You can select whether the measured value outputs display the test values or the last measured value during calibration; see “Selecting the output mode during calibration”, page 119.
- *Behaviour at zero point:* You can influence how the measured value outputs behave at the start value of the measuring range; see “Suppressing measured values at the start of the measuring range”, page 113. For example, this allows you to prevent negative measured values from being output.

Electrical signal

- The measured value outputs are galvanically isolated from the other internal electronics. However, when the minus pole is connected to ground (GND), the isolation is no longer maintained.
- The standard signal is 4 ... 20 mA; allowable load: 0 ... 500 Ω. As an option, voltage signals can be set-up at the factory, for example 0 ... 10 V.
- The electrical display range can be set to 0 ... 100%, 10 ... 100% or 20 ... 100% (corresponds to 0/2/4 ... 20 mA; see “Setting the “live zero”/deactivating a measured value output”, page 118).
- Negative electronic output signals are not available.

Additional information applies for option “intrinsically-safe measured value outputs”; (see “Intrinsically-safe measured value outputs”, page 74).

Fig. 19: Plug connector X7 (analog inputs, measured value outputs)



4.13 Analog inputs

Function

The S700 has two inputs for external analog signals (IN1, IN2; see Fig. 19). These two inputs only have to be connected when the S700 software considers these inputs. This applies only to special analyzer versions. Please check if your analyzer was delivered with corresponding technical information.

Possible uses of analog signal inputs (requires a special factory-made configuration):

- External cross-sensitivity compensation (see “Cross-sensitivity and gas matrix effect compensation”, page 31)
- Processing an external measuring signal as an internal measuring component, i.e. displaying the signal value as an S700 measuring component with all related analog and digital outputs – for example, for the measured value of another gas analyzer - this can also include the calibration of this signal, controlled by the S700.
- Calculation of measured values from an external analog signal and displaying these as an S700 measuring component – for example, for the measuring signal of an external sensor.

Information on the use of analog inputs can be found in the internal configuration data (output of data, see “Printing the internal configuration”, page 127; information see “Information on active compensations”, page 224).

Electrical signal

- *Input signal:* Set at the factory to voltage signal 0 ... 2 V or current signal 0 ... 20 mA (selectable). The internal resistance is 100 W (default value for R1 and R2). R1 and R2 can be removed when the internal resistance is too low for a voltage input signal.
- *Highest allowable signal:* 3 V or 30 mA. If this value is exceeded, then the message `FAULT: mA/V input` is displayed.
- The analog inputs are *not* galvanically isolated (minus pole is GND).

4.14 Switching outputs

You can test each signal connection individually without setting or changing any of the S700 functions (see “Testing electronic outputs (hardware test)”, page 144). This allows you, for example, to check the external wiring.

4.14.1 Switching functions

The S700 has 16 switching outputs which you can use in the following way:

- Switching contacts REL1, REL2 and REL3 are used for basic status messages (see “Available switching functions”, page 121). This assignment cannot be changed.
- The switch contacts REL4 ... REL8 and the transistor outputs TR1 ... TR8 can freely be assigned to any of the supplied status or control functions.
  - Which switch functions are available and how the desired assignment is made is described in Configuration of the switching outputs”, (see page 120).
  - A list of all the available switch functions is shown in User Table: Switching outputs”, (see page 236). You may want to use this Table to record your assignments.

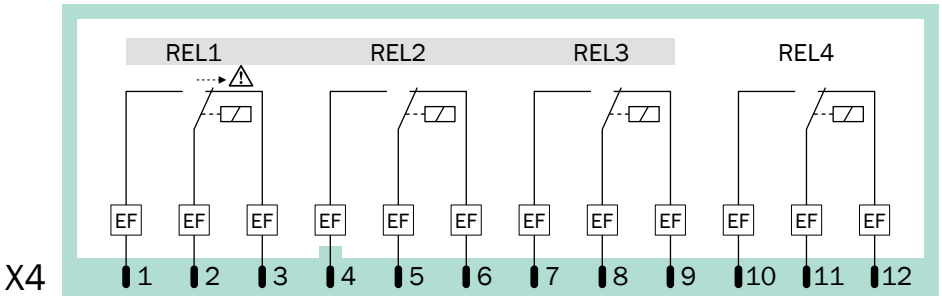
4.14.2 Electrical function

- Switching outputs REL1 ... REL8 are potential-free make&break contacts (see Fig. 20, page 71 and Fig. 21, page 71-).
- Switching outputs TR1 ... TR8 are transistor outputs (see Fig. 22, page 72), used for switching external loads. Use the internal auxiliary voltage for power supply; see “Outputs for signal voltage (auxiliary voltage)”, page 66.
- The switching outputs can be programmed to work according to the open-circuit or the closed-circuit principle; see “Control logic”, page 120.

Transistor outputs can be used to switch a higher load than specified if an external relay is installed between the transistor output and the load:
- Electronic shops offer various relay modules, for example with 8 electro-mechanical relays each. Make sure these are equipped with discharging diodes.
- Instead of electromechanical relays, you can also use solid-state relays (solid-state relays). Solid-state relays do not require discharging diodes and can directly be connected to the transistor outputs.

4.14.3 Contact connections (pin assignment)

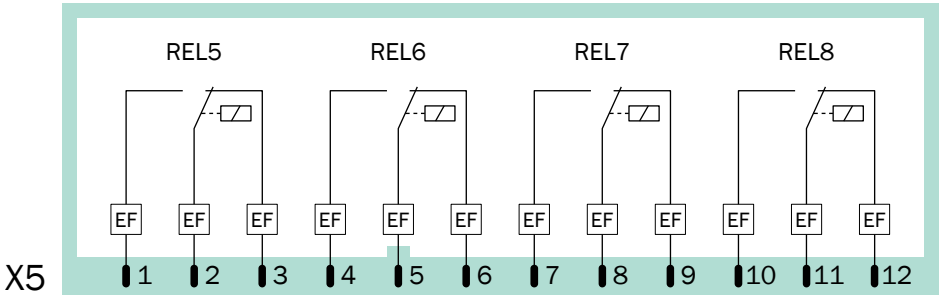
Fig. 20: Plug connector X4 (relay switching outputs)



NOTE:

- Observe the maximum contact load of the switching outputs; see “Maximum load of the signal connections”, page 66.
- Keep any voltage higher than 48 V (also as peaks) away from the signal connections; see “Maximum load of the signal connections”, page 66.
- Only connect inductive loads (for example, relays, solenoid valves) with discharging diodes; see “Anti-inductive protection for the signal connections”, page 67.

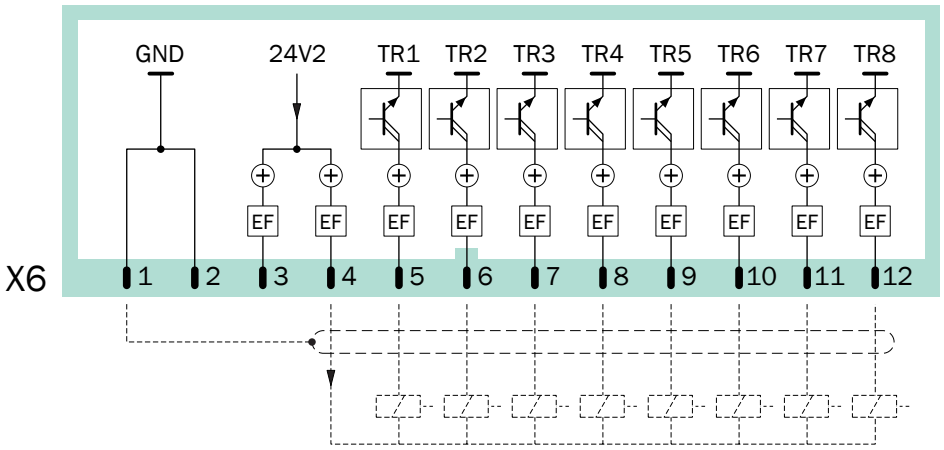
Fig. 21: Plug connector X5 (relay switching outputs)



NOTE:

- Observe the same information as for plug connector X4 - see Fig. 20.

Fig. 22: Plug connector X6 (transistor switching outputs)

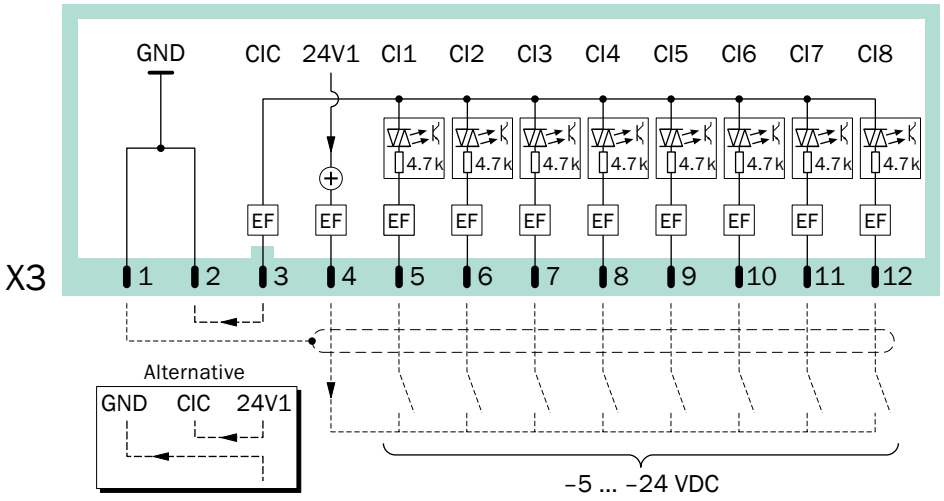


NOTE:

- To power these switches, use the internal auxiliary voltage source only (24 V DC see "Outputs for signal voltage (auxiliary voltage)", page 66).
- Observe the highest permitted load (maximum rating):
  - for a single transistor output: ≤ 250 mA (corresponds to ≤ 6 W /external load ≥ 48 Ω)
  - for the total of all transistor outputs: ≤ 500 mA (24 Ω)

  Higher loads (even short-term or peak) will immediately destroy internal components.
- Only connect inductive loads (for example, relays, solenoid valves) with discharging diodes; see "Anti-inductive protection for the signal connections", page 67.

Fig. 23: Plug connector X3 (control inputs)



NOTE:

- Do not supply more than ±24 V DC for the control voltage.
- Do not exceed the maximum peak voltage: 48 V (peak)

Higher voltages could damage internal components. In addition, safe separation of functional voltages would no longer be guaranteed.

4.15 Control inputs

4.15.1 Control functions

The S700 has 8 control inputs. Each of the control inputs can be freely assigned to any of the possible control functions; see “Configuration of the control inputs”, page 122.

A list of all the available control functions is shown in User Table: Control inputs”, (see page 237). You may want to use this Table to record your assignments.

4.15.2 Electrical function

Control inputs CI1 ... CI8 are optical coupler inputs (see Fig. 23, page 72).

- *Activation:* The logical function of a signal input is activated when current flows between the control input connection and the common pole of the control inputs (CIC).
- *Control voltage:* ±5 ... ±24 V DC. You can use an external voltage source or the internal auxiliary voltage (24 V DC see “Outputs for signal voltage (auxiliary voltage)”, page 66).
- *Polarity:* The optical coupler inputs are bipolar which means they can be activated selectively with either positive or negative voltage. Fig. 23 “Plug connector X3 (control inputs)” shows both alternatives when using an internal auxiliary voltage: The common pole (CIC) is connected either to GND (negative) or 24V1 (positive).
- *Galvanic separation:* The connections of the optical coupler inlets are electrically isolated, i.e. separated galvanically from the remaining S700 electronics. However, the galvanic isolation is no longer maintained when one of the connections is connected to another non-isolated S700 contact (for example, GND or 24V1).
- *Internal resistance:* 4.7 kΩ per control input.
- *External switch:* Mechanical switch contact or Open-Collector output.

NOTE:

▶ Do not connect the control inputs to voltages greater than 24 V.
Otherwise internal components could be damaged, and the safe separation of functional voltages is no longer guaranteed.

You can test the current state of each individual control input (see “Status of the control inputs”, page 141), for example, to check the wiring of the connections.

4.16 Intrinsically-safe measured value outputs

Only applies for enclosures with option "intrinsically-safe measured value outputs".

Function

Intrinsically-safe measured value outputs are realized with fitted additional modules (Zener safety barriers). Up to four measured value outputs are available as intrinsically-safe outputs.

NOTE:

▶ Observe the maximum permitted load for the intrinsically-safe outputs:

Damage through overload

- Allowable load: 0 ... 390 Ω (!)
- Maximum voltage at the terminal connections: 18 V

WARNING: Safety risk in potentially explosive atmospheres

Intrinsically-safe circuits fulfill special explosion protection requirements. To achieve the desired explosion protection:

▶ Provide "intrinsically-safe" devices for all circuit components.
▶ Maintain the specified connection values (see below).
▶ Install the entire circuit properly.

Permitted connection values

The intrinsic safety of a intrinsically-safe measured value output will only be achieved when the connected circuit (including the cable lines) conforms to the following values:

Table 10: Permitted connection values for intrinsically-safe meas. value outputs (option)

Electrical parameter of the connected circuit	For protection class Ex-ia, explosion group IIB	For protection class Ex-ia, explosion group IIC
Total inductivity L_0	≤ 7.35 mH	≤ 1.25 mH
Total capacity C_0	≤ 800 nF	≤ 104 nF
Maximum voltage U_0	25.2 V	
Maximum current I_0	121 mA	
Maximum power P_0	760 mW	

CAUTION: Individual application may require reduced values

The individual application may require lower values. It depends on the composition of the explosive atmosphere.

▶ Check the European Standard EN 60079 -0 "Electrical apparatus for potentially explosive atmospheres" to find out the maximum permitted connection values for the individual application.
▶ *If this results in limitations:* Note these limitations (for example, in this document) and consider during installation.

Further information on intrinsically-safe equipment is given in the European Standard EN 60079 -11 "Intrinsic safety "i"".

Connection

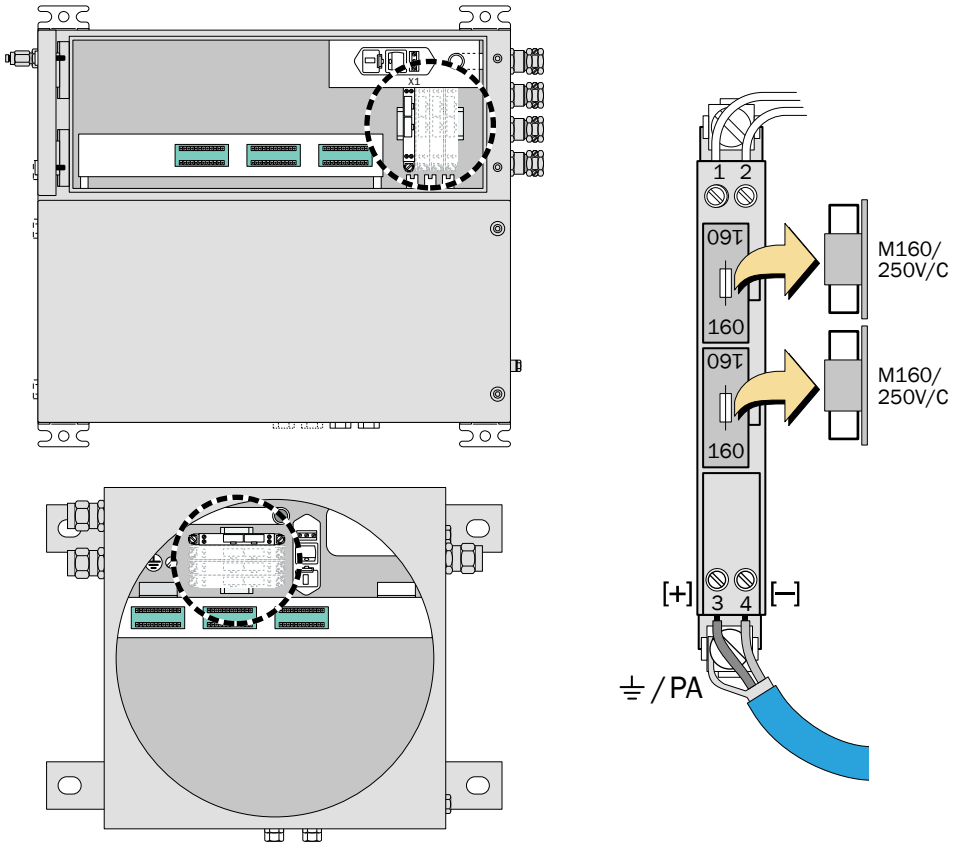
▶ Connect the signal cable to the module (see Fig. 24, page 75):

[+]	→	Terminal 3
[–]	→	Terminal 4
Shield	→	Terminal PA

▶ Install the signal cable in compliance with standard EN 60079-11/14 :

WARNING: Risk of explosion
Intrinsically safe installations must maintain a certain clearance from other electrical equipment (specifications see EN 60079-11/14).
▶ Install cables of “intrinsically-safe” circuits so that the required distance to other electrical devices is always maintained.

Fig. 24: Intrinsically-safe measured value outputs



4.17 Digital interfaces

4.17.1 Function of the interfaces

- The S700 digital interfaces are serial interfaces (RS232C/V.24).
- Interface #1 can serve to use a remote control: The S700 receives commands and sends measuring results and status messages via the interface on command. This feature is available during operation
  - With “limited AK protocol” option (see “Remote control with “AK protocol””, page 182)
  - With Modbus remote control functions (see “Remote control with Modbus”, page 188).
- Interface #2 is used to send measuring and calibration data and status messages.

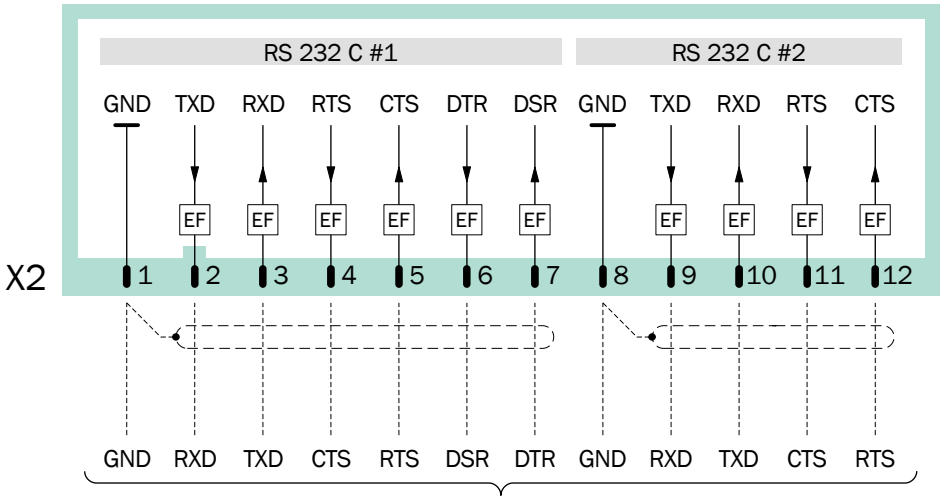
4.17.2 Connecting the interfaces

To use one of the interfaces:

1. Connect the external device to the relevant interface of the S700 (see Fig. 25, page 76; further information see “Creating an interface connection with a PC”, page 231).
2 Set the interface parameters of the S700 and connected devices so that these are identical; see “Digital interface parameters”, page 124.
3 *For interface #2:* Select whether the S700 should output certain data automatically; see “Output of digital measured data”, page 125.

- A serial interface can only work when the interface parameters of all connected instruments are identical.
- To use a function to test data output; see “Testing electronic outputs (hardware test)”, page 144.

Fig. 25: Plug connector X2 (interfaces)



NOTE:
Maximum peak voltage for the digital interfaces = ±15 V

4.18 Ethernet interface converter for Modbus TCP communication

4.19 Intended use

The interface converter enables the use of Modbus TCP and remote control via MARC2000.

4.20 User qualification

The device may only be operated by authorized persons who, based on their training on, and knowledge of the specific device, as well as knowledge of the relevant regulations can assess the tasks given and recognize the hazards involved.

4.21 Product description

Two applications are feasible with the “Ethernet interface converter” option.

4.21.1 Application 1 - Virtual serial interface

In this application, the interface converter makes the serial interface of the S700 available to remote PCs via the network. An additional program is required for use, which can be downloaded from PhoenixContact.

Once the connection has been set up, the virtual serial port of the accessing PC can be used for the following tasks:

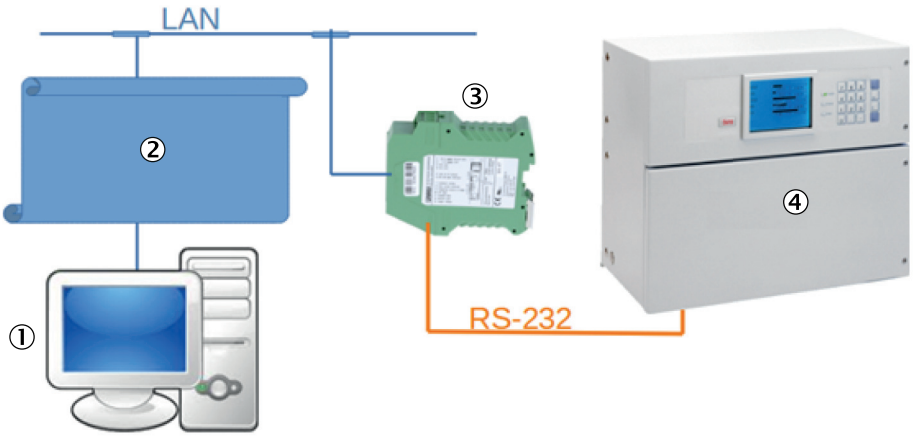
- Remote control of the device via Endress+Hauser “MARC2000” software
- After activating the Modbus ID in the S700: Communication with the device via Modbus RTU

With an existing Meeting Point Router (MPR) from Endress+Hauser, remote maintenance by Support is also possible without setting up a virtual port.

Functional principle

A COM port redirector driver is installed on the PC, which provides a virtual COM port. When the virtual COM port is opened, the driver connects to the IP of the FL-COM server via the network connection and sends the serial data to the FL-COM server via the network. The FL-COM server “translates” the incoming data back into the serial RS232 format and communicates with the S700 via this serial connection.

The illustration below shows the layout with description.



1 PC with LAN connection
2 Virtual Com port (driver)
3 FL-COM server
4 S700 (illustration may differ)

Fig. 10: Application - Virtual serial interface

4.21.2 Application 2 - Modbus TCP gateway

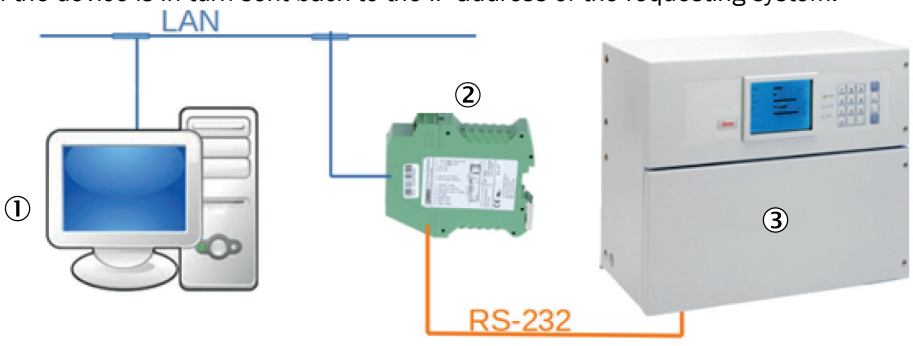
In this application, the interface converter is used to translate the Modbus RTU (serial) protocol to Modbus TCP Client (Ethernet) (gateway). This makes the Modbus of the S700 accessible to higher-level systems via Ethernet. In contrast to serial communication, it is also possible for several systems to access at the same time.

The following tasks can be carried out:

- Integration of the S700 in Modbus TCP communication networks

Functional principle

The interface converter is operated in “Modbus/TCP” mode. Port 502 is opened on the set IP address of the interface converter and the interface converter makes itself available as a Modbus TCP server. The content of incoming Modbus TCP requests is extracted and the message is forwarded to the device whose ID is contained in the telegram. The response from the device is in turn sent back to the IP address of the requesting system.



1 PC with LAN connection
2 FL-COM server
3 S700 (illustration may differ)

Fig. 11: Application - Modbus TCP gateway

4.22 Usage

4.22.1 Preparations

Additional preparation for enclosure variants S710 / S711

1. Mount COM server on top-hat rail.
2. Connect the 24 V power supply to the terminal.
3. Connect the SIDOR/S700 to the serial interface with the standard cable (part number: 2135520).

Preparations for all enclosure variants

4. Connect the converter with Ethernet cable directly to a PC for configuration.

4.22.2 Changing the IP address

1. Change the IP address on the PC to 192.168.0.100.
2. Open the web browser to access the web interface and enter the IP address of the FL-COM server (default: 192.168.0.254).
3. Call up menu item “General configuration”-“IP”.
4. Log in with the password “private”.
5. Change the setting according to the internal specifications.

To prevent communication problems, it is recommended to assign a static IP address.

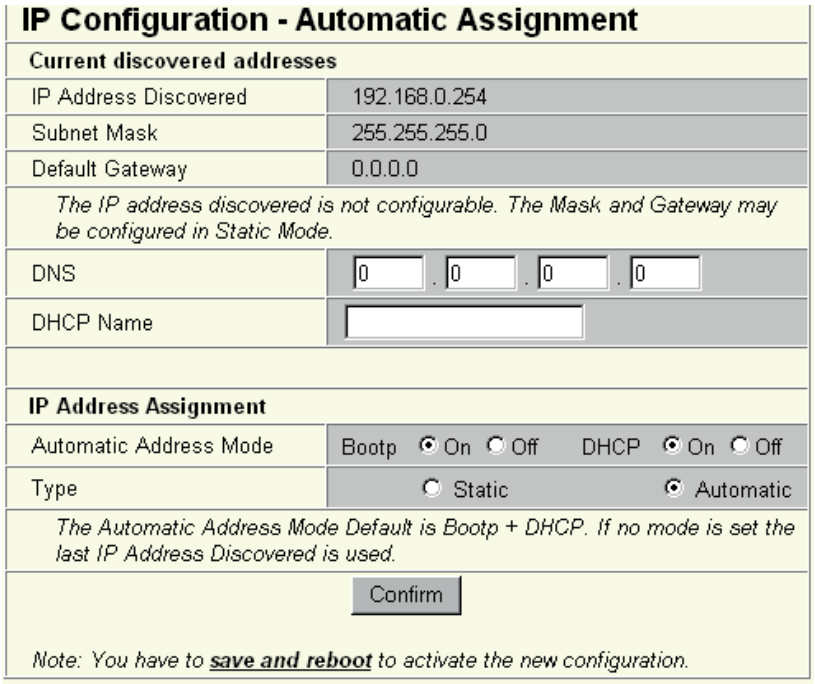


Fig. 12: IP Configuration - Automatic Assignment

The menu shown displays the current IP parameters and addressing mechanism. To change the IP parameters via the web based management, the “Static” selection must be activated.

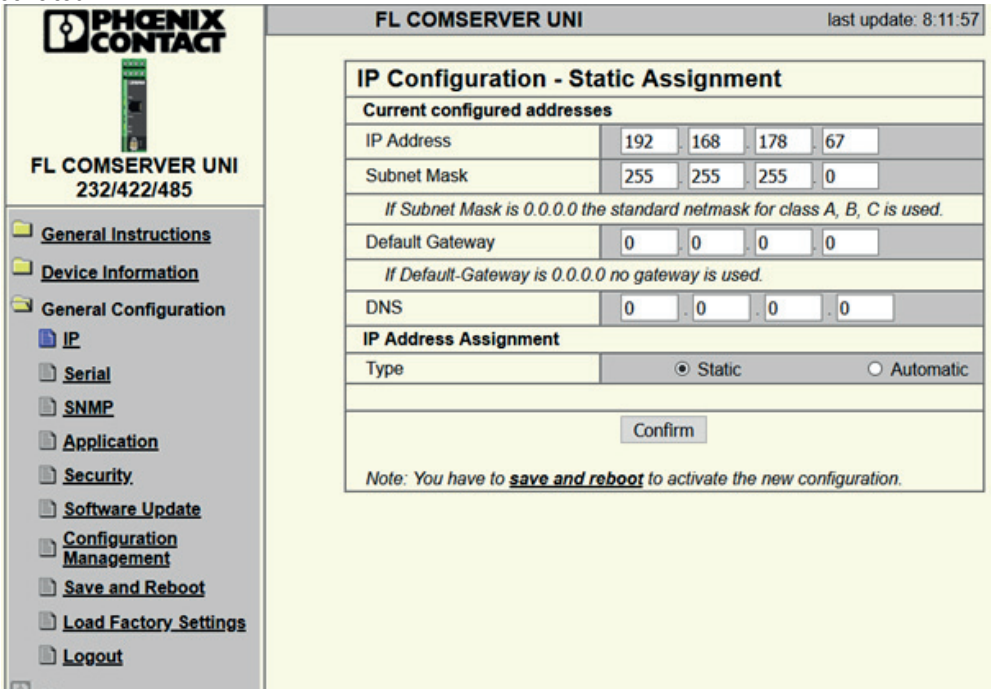


Fig. 13: IP Configuration - Static Assignment

4.22.3 Change the password

1. Navigate to “General Configuration” - “Security”

Specify the current password to then assign a new password. The password for write
2. access is “private” on delivery.

The password must be between four and twelve characters long.

The password is transmitted over the network without encryption.

If the password is not known, an emergency access via the serial interface is available. With the help of e.g. Hyperterminal, the device can be reset to the delivery state.

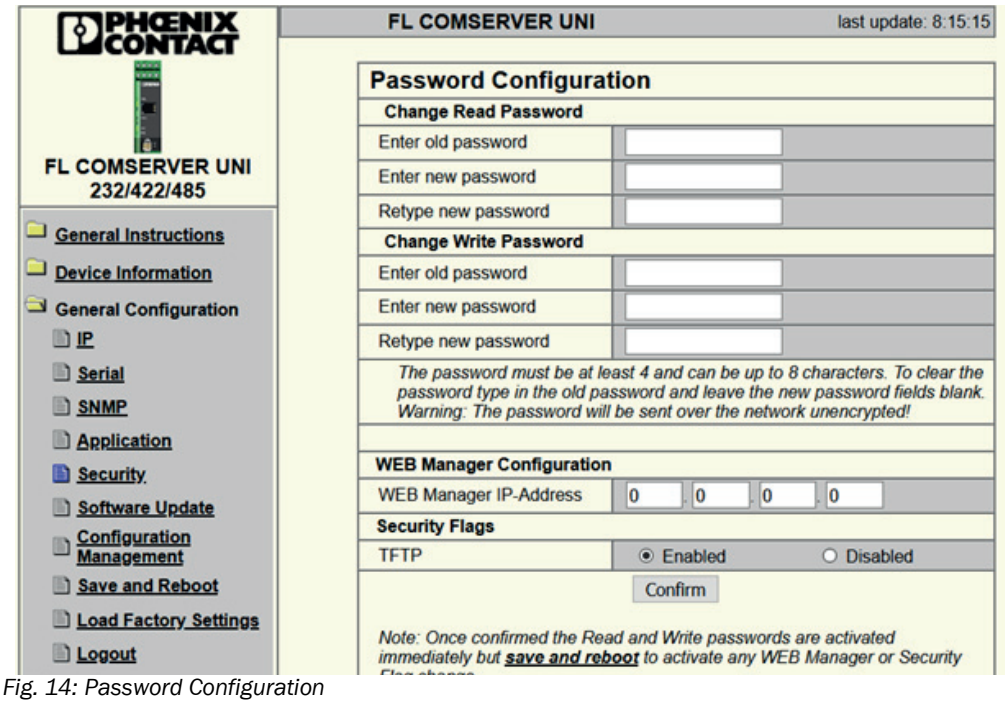


Fig. 14: Password Configuration

4.22.4 Settings for Application case 1 - Virtual serial interface

Setting

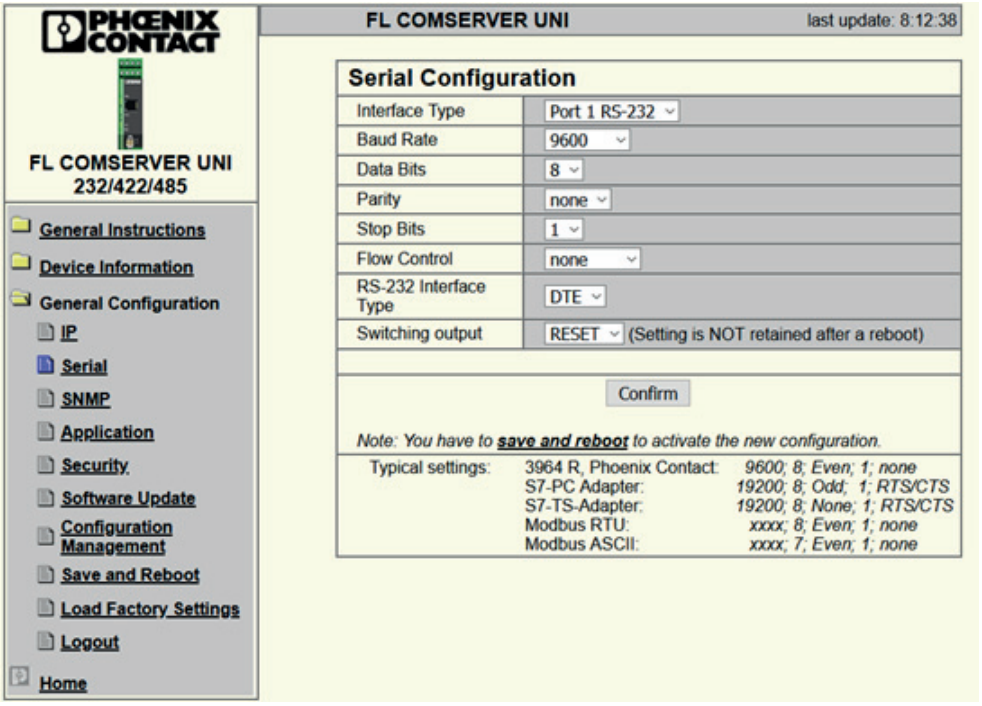


Fig. 15: Serial Configuration

1. Navigate to “General Configuration” - “Serial”
2. Set the serial interface as shown in the Figure.

3. Confirm with “Confirm”.

> The configuration of the serial parameters must correspond to the configuration set in the S700.

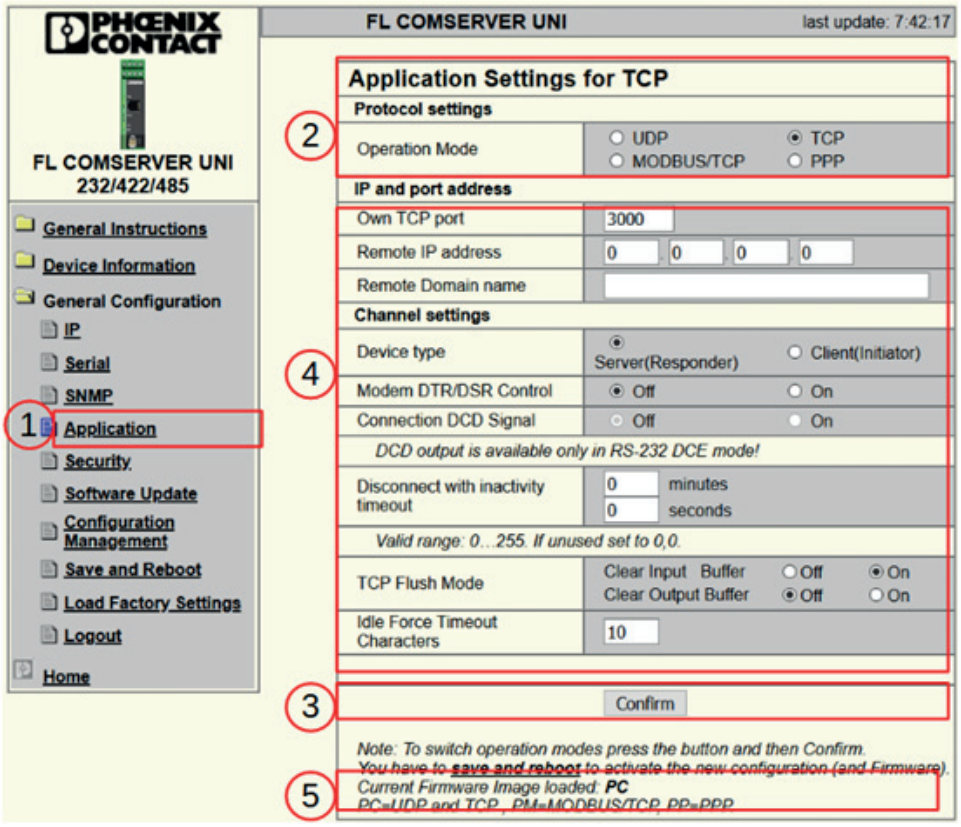


Fig. 16: Application Settings for TCP

4. Navigate to “General Configuration” - “Application” (1)
5. Under “Protocol settings for TCP” (2), change the Operation Mode to TCP..
6. Confirm with “Confirm” (3).

> The web interface is created dynamically depending on the Operation Mode. It may therefore be necessary to activate “Save” and “Reboot” after changing the Operation Mode (see Fig. 17) so that the menu (4) is displayed.

7. After the restart, the corresponding operating mode “PC” for TCP is displayed in the lower field of the configuration (5).

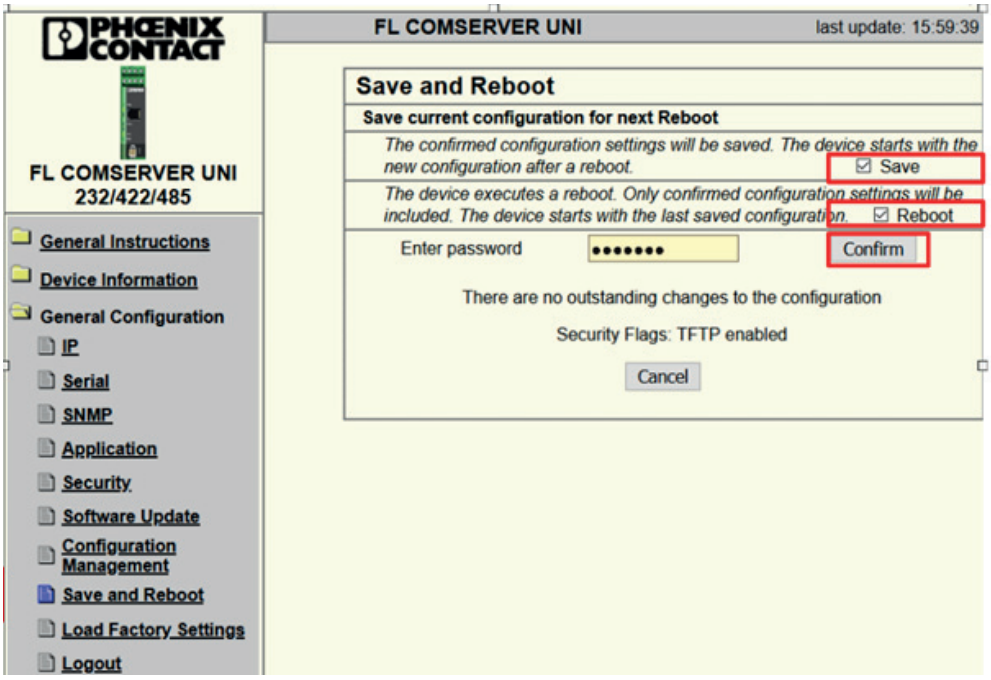


Fig. 17: Save and Reboot

After complete configuration: Permanently save and activate the settings with the “Save
8. and Reboot” routine. Enter the password to confirm the entry.

Set up the COM port

1. Download FL-COM-Port Redirector 1.50 from PhoenixContact and install it with administrator rights.

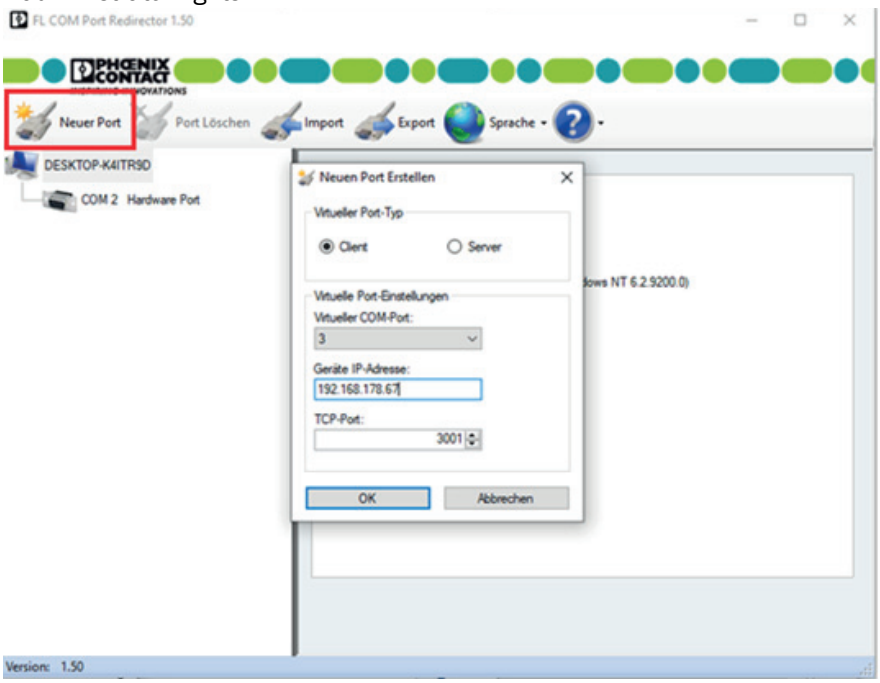


Fig. 18: Creatingthe virtual COM port

2. After starting the FL COM-Port Redirector 1.50, create a new virtual COM port.
3. Set the mode to “Client” (see Fig. 18).

4. Select a free port number (for a remote control with MARC2000, the port number must be in the range 1-6).
5. Enter the IP of the FL COM server under “Geräte-IP-Adresse” (Device IP address).
6. Leave the TCP port at 3001.

Setting up the remote control with MARC2000

1. Download MARC2000 from ***www.endress.com/downloads*** and install it.
2. Start MARC2000.
3. Navigate to “Optionen” (Options) - “Schnittstellen-Parameter” (Interface parameters).
4. Select the “COM-Anschluss” (COM port) defined in Chapter „Set up the COM port“.

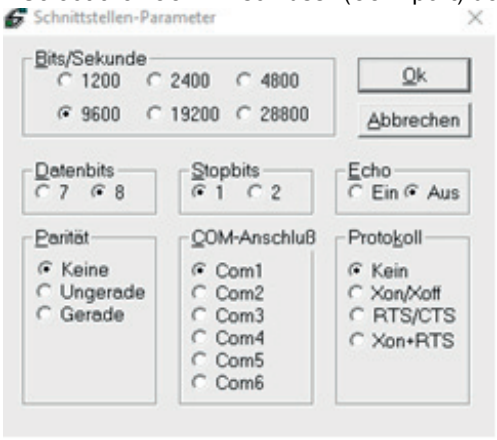


Fig. 19: Interface parameters

5. Navigate to “Ausführen” (Execute) - “PC-Steuerung” (PC control).
6. Create a connection.

» Content is displayed in the black area.

7. The analyzer can now be operated via the virtual keypad.

Fig. 20: MARC2000 configuration

4.22.5 Settings for Application case 2 - Modbus TCP gateway

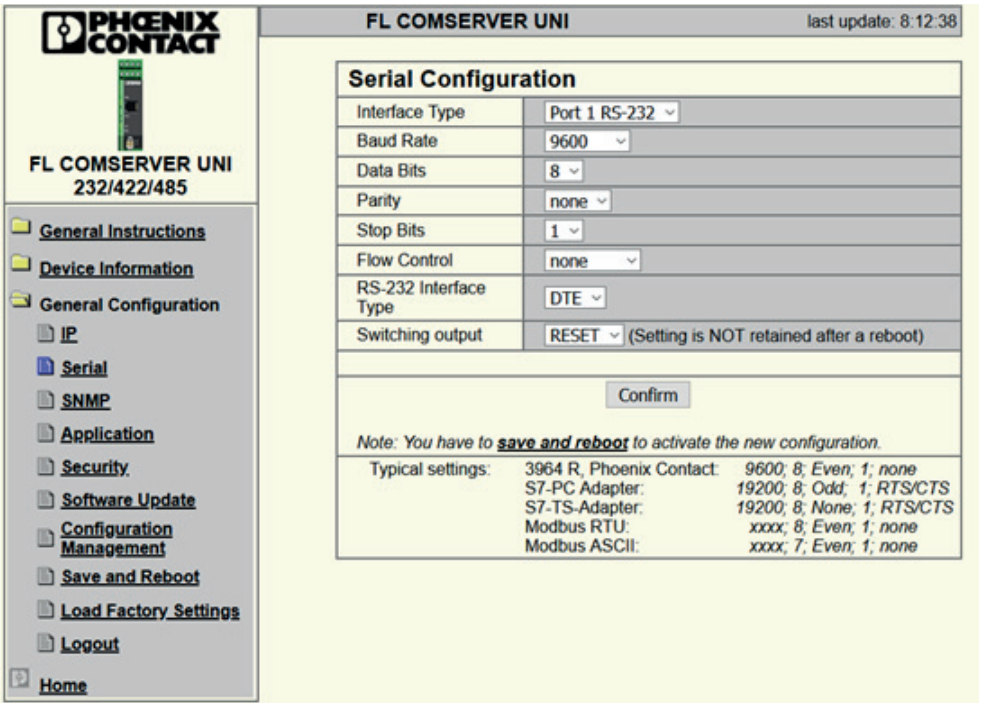


Fig. 21: Serial Configuration

1. Navigate to “General Configuration” - “Serial”
2. Set the serial interface as shown in the Figure.
3. Confirm with “Confirm”.

> The configuration of the serial parameters must correspond to the configuration set in the S700.

4. Navigate to “General Configuration” - “Application”
5. Under “Protocol settings for TCP”, change the Operation Mode to “MODBUS/TCP”.
6. Confirm with “Confirm”.

> The web interface is created dynamically depending on the Operation Mode. Therefore, it may be necessary to activate “Save” and “Reboot” (see Fig. 17) after changing the Operation Mode so that the menu is displayed.

7. After the restart, the corresponding operating mode “PM” for“ MODUBUS TCP” is displayed in the lower field of the configuration.
8. Under “Channel Settings” - “Device Type”, select the option “Slave”.
9. Under “Protocol”, select the “RTU” option.
10. Under “Slave Remote TCP”, enter 502.
11. Confirm with “Confirm”.
12. Use the link to switch to the “Save and Reboot” menu.
13. Confirm by entering the password and pressing “Confirm”.
14. After the restart, the device can be reached under the selected IP address on port 502 for Modbus TCP requests.

> The “ID” in the Modbus TCP request must correspond to that of the S700 (setting in menu 6421), as it is a gateway.

> For address assignment, function codes and restrictions, consult the S700 Operating Instructions (remote control with Modbus).

4.22.6 Emergency configuration

If the possibility for a WBM device configuration via network is not available, e.g. because the set static IP address is unknown, it is possible to use the serial emergency access.

For this purpose, local access to the device and a PC with a terminal program must be connected to the RS-232 interface.

Function scope

The following are available for emergency configuration:

- Configuration of the IP address / activation of the BootP mechanism
- Deleting all settings (incl. passwords) and resetting to factory settings
- Loading new firmware
- Complete device configuration by loading a file

Procedure

1. Connect the FL COM SERVER UNI to a serial COM port of a PC.
2. Open a terminal program, e.g. Hyperterminal in the Windows start menu under “Programs” - “Accessories” - “Communication” - “Hyperterminal”.
3. Configure the interface (e.g. COM 1) under “Datei” (File) - “Eigenschaften” (Properties) to 9600 bit/s; No parity; 1 stop bit; No flow control.

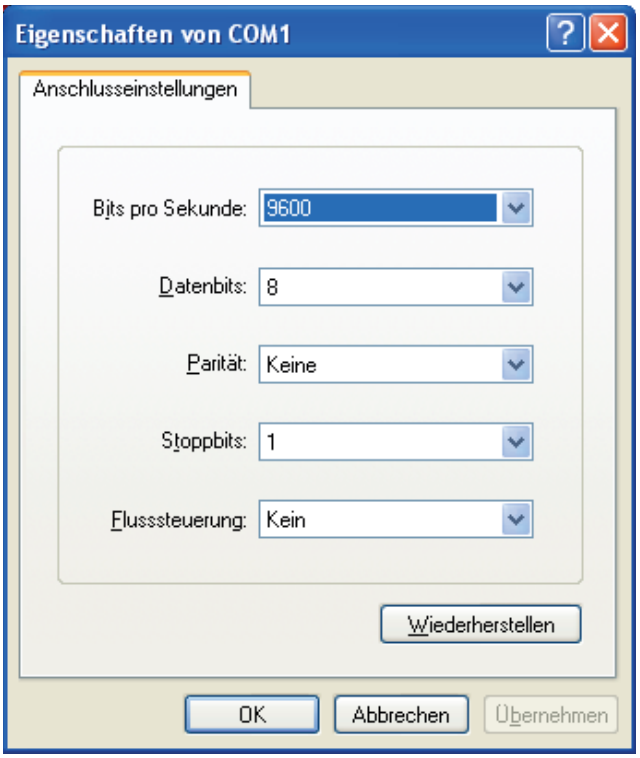


Fig. 22: “Eigenschaften” (Properties) menu in the Windows hyperterminal

4. Confirm the settings with “OK” and close the menu.
5. Check the settings in the status bar of the hyperterminal.
6. Perform a power reset on the FL COM SERVER UNI while holding down the X key on the keypad.

7. As soon as a response from FL COM SERVER UNI appears on the screen, press the Enter button within 3 seconds. The following Figure appears:

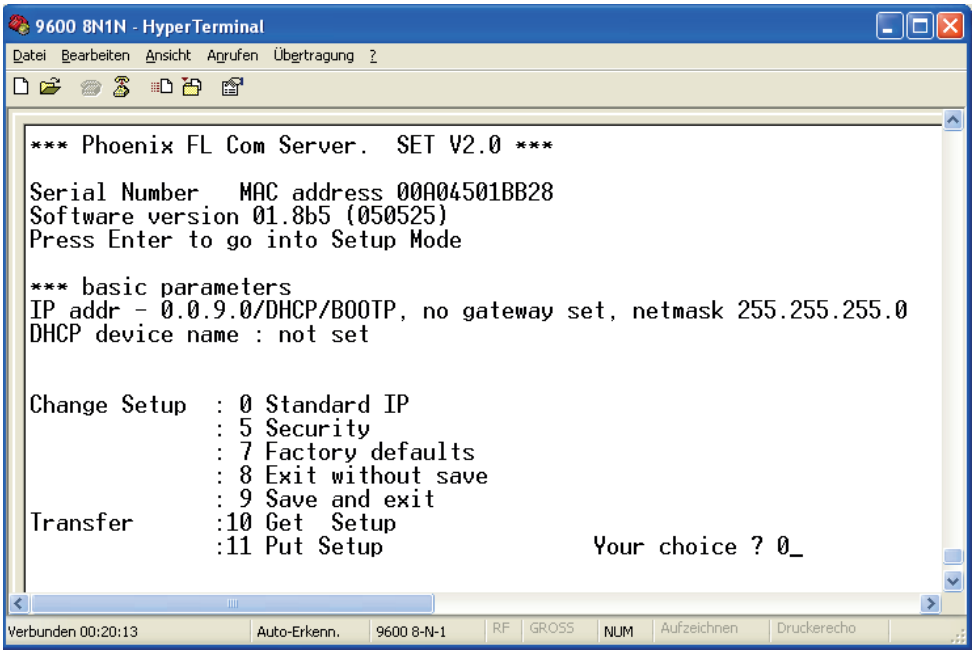


Fig. 23: Serial setup menu

8. Select the desired option by entering the number and confirm by pressing the Enter button.

5 Commissioning

5.1 Switch-on procedure

1. Check/prepare

▶ Make sure the S700 is set to the correct power voltage (see “Adapting to power voltage”, page 209).
▶ Make sure the sample gas conditioning is working (see “Designing the sample gas feed”, page 46).

In potentially explosive atmospheres:

▶ Make sure the enclosure is closed tight (see “Closing the enclosure”, page 57).
▶ *S715 Ex/S715 Ex CSA – if the enclosure has been opened:* Perform a leak tightness check (see “Leak tightness check for the enclosure S715 Ex”, page 203).
▶ Check the state of the connection cables.

2. Start-up

▶ Switch-on the external main power switch (see “Installing a separate disconnector switch”, page 61). – For S710/S711 alternatively/additionally: Switch the main power switch at the rear on (see Fig. 14, page 62).

Automatic procedures after power-on:

- LED activities (when free from malfunctions and alarms):

LED	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
“Function”	red/green	red	red	red	green[1]
“Service”	on	on	on	off	off
“Alarm”	on	on	off	off	off

[1] when the operating temperature is reached and sample gas flow is established (gas pump on)

- The microprocessor system tests the S700 hardware. The display will show:

```
128 KB Ram & 1 MB Flash Memory ......
Real-Time Clock .....................
System Timers .......................
CPU Clock = 20.000 MHz ..............
Processor: AM188ES Rev.:   B
Mainboard Version:    ...............
Startup-Code Version: xxxxxxx........
8 KB non-volatile Parameters RAM.....
Power-Supply Voltages & ADC .........
      --- Tests finished ---
```

If no fault is detected, then `OK` will appear at the end of each line.

- The microprocessor system tests the data memory integrity.

»» *If the test was error-free:* The measuring display appears (see “Measuring displays”, page 97).

»» *If an error was detected:* The microprocessor will automatically recover the state saved after the last calibration (see “Using an internal backup”, page 132). This makes the S700 operative again. Then the measuring display is shown and the warm-up time begins.

3. Wait for heating up time to complete

As long as the internal operating temperature is not reached, the LED “Function” will be *red* (at least for 2 minutes; status message: `Heating up`).

▶ Wait until the LED “Function” is *green*.
▶ Then wait another 2 hours for the internal temperature to stabilize.

4. Prepare the measuring operation

▶ see “Measurement preparation”.

5.2 Measurement preparation

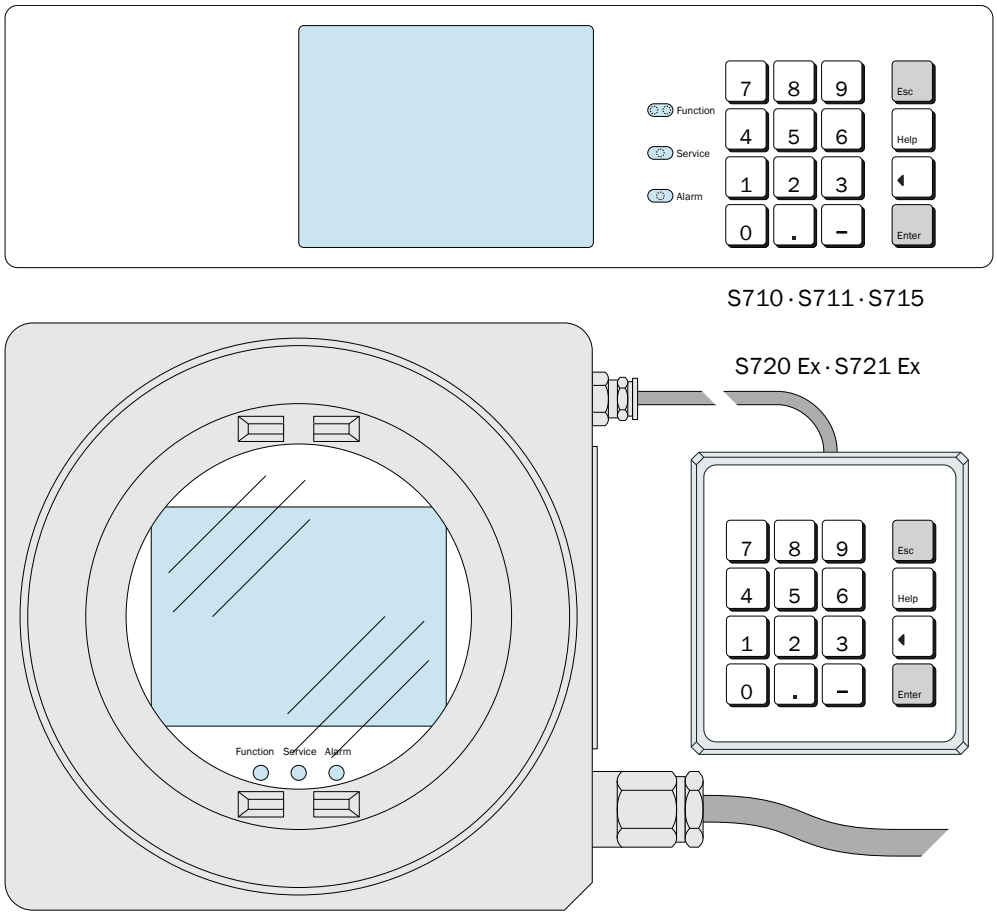
▶ *Before binding measurements are made:* Check the calibration of the S700 (see “Calibration”, page 146). Only a correctly calibrated analyzer delivers correct measured values. Check the calibration even if you have a brand-new device.

CAUTION: Risk of wrong analysis
Without correct calibration, the measuring results might be wrong.
▶ Always perform a new calibration
- when the S700 has been switched off for a longer time (for example, for more than 14 days)
- when changes have been made to the S700 (for example, when sub-assemblies have been changed)
- when something has been changed in the external gas-technical installation (for example, the sample gas cooler)
- the S700 has been transported.

▶ *If the S700 has a built-in gas pump or controls an external sample gas pump or a corresponding solenoid valve* *(see “Configuration of the switching outputs”, page 120)*: Switch on the `Gas pump` function; see “Switching the gas pump on/off”, page 104.

6 Operation (general)

Fig. 26: Operating and display elements



6.1 LEDs

After power-on, all these LEDs are on temporarily (see “Switch-on procedure”, page 89).

Function (green/red)

- A *green* light indicates that the S700 is operationally ready and the measuring function can be started.
- A *red* light indicates that the S700 is not operationally ready. Possible causes :
  - After power-on, the operational temperature is not reached yet (see “Switch-on procedure”, page 89).
  - The S700 has detected an internal fault (for example, electronics defective)
  - The measuring function is disturbed (for example, the sample gas flow is too low ,the internal temperature is too low).

  Function “red” corresponds to the status output signal “Fault” (see “Available switching functions”, page 121). In most cases, the reason for the malfunction is indicated on the display (see “Status messages on the display”, page 92).

Service (yellow)

If the “Service” LED goes on during normal measuring operation, this signals a problem is starting. The measuring function is not (yet) affected by this state, but a technician should fix the problem soon. – In these cases, the “Service” LED corresponds to status output “Malfunction” (see “Available switching functions”, page 121).

The “Service” LED is also on

- when a calibration is running (+ a certain time afterwards, see “Setting test gas delay time”, page 161)
- when the menu branch `Service` is in use (see “Main menu”, page 96)
- when the Maintenance signal is activated (see “Activating the maintenance signal”, page 107).

Alarm (red)

Is on when at least one measured value is beyond a programmed alarm limit value. In addition, the following message appears on the display (example):

```
CO2    >    250.00 ppm
```

(= “the current CO_2 measured value is greater than the set limit value 250.00 ppm”).

- Set the alarm limit values see “Setting alarm limit values”, page 114
- Program the related switching outputs (see “Configuration of the switching outputs”, page 120)

6.2 Status messages on the display

In the second to last display line, the S700 shows a message,

- when an internal limit value is exceeded (`SERVICE: ...`)
- when a faulty state or a malfunction is detected (`FAULT: ...`)
- when an operating state exists which affects the analysis.

If several status messages exist at the same time, then `CHECK STATUS/FAULTS` is displayed instead. The list of all current status messages can be found using the `Status/Faults` menu (see “Display of status/malfunction messages”, page 100).

- Example of a status line see “Principle of operation”, page 93
- Clarification of status messages see “Status messages (in alphabetical order)”, page 211.

6.3 Principle of operation

6.3.1 Function selection

- For function selection, the Display shows various “menus” with various selection options. The starting point is the `main menu` (see “Main menu”, page 96).
- To select a particular function, press the related number key.
- Using the various menu functions, you can
  - enter parameters (for example, limit values for “Alarm” signals)
  - start routines (for example, calibration)
  - test device functions.
- If a measuring display was activated when the analyzer was shut off (see “Measuring displays”, page 97), then this display will be re-activated when it is switched on again. To call-up the `main menu`, press the [Esc] key twice.

6.3.2 Display of menu functions (example)

Display	Operating step / notes
`Device status  2`	← menu number and selected function
`1 status/faults`	← These ...
`2 measuring ranges`	← ←
`3 signal outputs`	← ←
`4 alarm limits`	← ←
`5 device data`	← ←
`6 absolute drift`	← ...are the possible selections in this menu
`Enter digit`	← Operating note [1]
`Heating up ...`	← Status message (example; see “Status messages on the display”, page 92)
`CO2  492.15 ppm`	← Current measured values [2]

[1] The operating information shows how to navigate further (here: Press a number key). To cancel a function, use the [Esc] key.
[2] Even during menu operations, the current status message (if there is one) and the current measured values are shown at the bottom line of the display.

6.3.3 Keypad functions

Next to the numerical keys (numbers 0 to 9, decimal point, minus key), there are four function keys for the S700:

Key	Meaning	Function
Esc	Escape	Ends the displayed function and returns to the preceding menu, without changing the device status. Pressing [Esc] several times leads back to the main menu.
Help	Help	Provide information on the menu or function currently displayed.
◀	Backspace	Deletes the last digit of the current entry.
Enter	Enter	Enters the input or displayed value and stores it as the new value.

- In most of the input procedures, the currently stored value is shown after `Status`. When you have entered a new value, press [Enter] to store this new value.
- The S700 can give an acoustic signal on each keypad entry. The tone intensity is adjustable; see “Setting the keypad click”, page 106.
- Even during menu operation, the S700 is permanently analyzing. This is why the S700 may sometimes react a little slow to a keypad entry.

If you wish to learn about the operating functions, you can call-up menus and [Help] texts as you like. As long as you don’t press the [Enter] key in an input menu, you will not change any of the settings.

6.3.4 Menu levels

The S700 menu functions are sub-divided into 4 “menu levels”:

- Standard functions
- Expert functions
- Hidden expert functions
- Factory settings

Standard functions

Are categorized as the operating functions, necessary for routine operations of the S700. With this group of functions you can:

– Check the device status on the display
– Switch the sample pump on and off
– Activate a status output to signal that maintenance work is currently in progress
– Start or run a calibration.

Description of these functions see “Standard functions”, page 96.

Expert functions

are used for setting device parameters and for device testing. These are only available after pressing a certain key (see “Access to the expert functions”, page 108). The Expert functions serve to for example:

– Set the limit values for “Alarm” messages
– Set the power of the built-in gas pump (option)
– Set the communication parameters of the digital interfaces
– Set-up the automatic calibration routine
– Enter the nominal values of the calibration gases
– Test all inputs and outputs

Some advanced expert functions are only available after entering a certain code (see “Access to the expert functions”, page 108). Such functions serve to, for example:

– Assign a switching function to each of the configurable signal connections
– Influence how the measured value output works
– Save all the settings and restore previous settings

Description of the expert functions see “Expert functions”, page 108.

- You should only use the expert functions when you are completely familiar with the effects of the function settings and you understand the procedures.
- If a switching input with the function “Service lock” has been set up and activated, then many of the menu functions cannot be used (see “Available control functions”, page 122).

Factory settings

In the “Factory settings” menu, factory-trained technicians can set and change basic device settings. Access to this group of functions is not shown in the menus and is only accessible with a pass code.

The factory settings are not described in these Operating Instructions.

7 Standard functions

7.1 Main menu

Main menu	
1 measuring display	← Standard functions
2 device status	←
3 control	←
4 calibration	←
5 maintenance signal	←
6 settings	← Expert functions [1]
7 service	←
Enter digit	← Operating note
No messages	← Status messages
CO 12 mg/m3	← Measured values (alternating)

[1] see “Expert functions”, page 108

7.2 Measuring displays

7.2.1 Combined display for all components

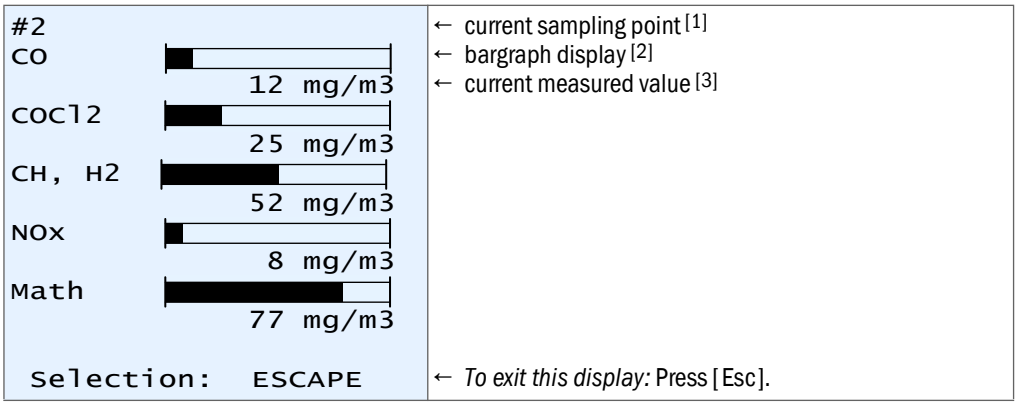
Function

This type of display allows you to see all current measured values at the same time.

Call-up

▶ Select `main menu → measuring display → all components`.

The following appears on the display (example):



[1] Only shown when the sampling point selector is activated (option; see "Sampling point selector (option)", page 142.
[2] Symbolizes the magnitude of the current measured value, either in relation to the measuring range or to the output range; see "Bar graph range selection", page 110.
[3] Possibly the measured values are displayed more accurate than the specified measuring precision would allow; see "Select number of decimal places", page 110.

- The display contrast is adjustable; see "Setting the display contrast", page 106.
- When a measured value exceeds the internal calculation limits, the S700 displays a malfunction message. This warning can be disabled; see "Activating warnings of working range limits (overflow warnings)", page 115.

It is possible that a measuring component represents the measured value of another device, or a value calculated from an external measuring signal; see "Analog inputs", page 69.

7.2.2 Large display for one selected component

Function

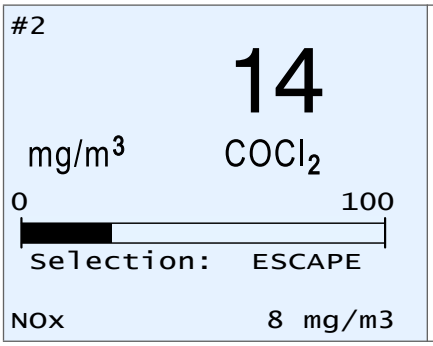
You can select a large version of the measuring display for just one particular measuring component – for example, to observe this measured value more closely. The measured values for the other components are displayed in text line underneath.

> It is possible that a measuring component represents the measured value of another device, or a value calculated from an external measuring signal; see "Analog inputs", page 69.

Call-up

1. Select `main menu → measuring display`
2 Select the desired measuring component.

The following appears on the display (example):



← current sampling point [1]
← current measured value [2]
← physical unit, measuring component
← End value of the physical measuring range [3]
← bargraph display [4]
← *To exit this display:* Press [Esc].
← other measured values (shown sequentially)

[1] Only shown when the sampling point selector is activated (option; see "Sampling point selector (option)", page 142.
[2] Possibly the measured values are displayed more accurate than the specified measuring precision would allow; see "Select number of decimal places", page 110.
[3] The S700 displays measured values which exceed the maximum values within limits, however, the precision of these measured values is not known.
[4] Symbolizes the magnitude of the current measured value, either in relation to the measuring range or to the output range; see "Bar graph range selection", page 110.

7.2.3 Chart recorder simulation

Function

The S700 can graphically show the trend of the measured values. This functions the same way as on paper in a chart recorder: Current sampling points appear at the top and "wander" slowly downwards. In this way you can continuously monitor the trend of the measured values. The time scale is adjustable from 1 to 32 hours. The value range corresponds to the current output range.

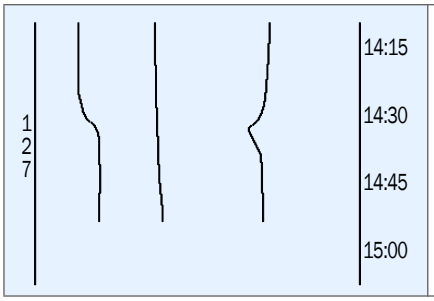
In addition, you can have the analyzer display the following values:

- Signal of analog input IN1 (see "Analog inputs", page 69)
- Temperature inside the S700 (numerical display see "Status of the internal controllers", page 139)
- Sample gas pressure / atmospheric pressure (numerical display see "Signals of the internal sensors and analog inputs", page 139)

Call-up

1. Select `main menu → measuring display → chart recorder`.

Then a display like this is shown:



← top: current sampling points [1]
←
← bottom: previous sampling points
←
←

[1] Start of the range = left

- If you do not see any measuring line, there are possibly no previous measured values available to display. Try selecting the smallest time interval (see below) and wait for a few minutes.
- Moreover, you might not see “lively” chart lines when the measured values are constant (for example, when they are “0”), or when they are identical, or if there are no measured values activated to display.

2 Using the keypad, select which measured values should be displayed:

Key	Toggles the display on/off for
[1]	measured value of the measuring component assigned to output OUT1
[2]	measured value of the measuring component assigned to output OUT2 [1] [2]
[3]	measured value of the measuring component assigned to output OUT3 [1] [2]
[4]	measured value of the measuring component assigned to output OUT4 [1] [2]
[5]	measured value of the fifth meas. component (not assigned to any output) [1]
[6]	internal temperature (0 ... 100 °C)
[7]	measured value for the built-in pressure sensor (900 ... 1100 hPa)
[8]	analog input signal IN1 (0 ... 5 V)
[9]	all values [1] ... [8]
[0]	no values

[1] If available
[2] If a measuring component is assigned more than once, only *one* line will be displayed

3 Select the desired time interval to be displayed:

Key	Effect
[Enter]	Toggles the time interval in steps: 1/32/16/8/4/2/1/32/... hours
[.]	Shifts the time interval 25% towards the past
[-]	Shifts the interval 25% towards the present [1]
[<]	Resets to default setting (starting time = present, interval = 1 hour)

[1] if the interval was previously shifted towards the past

- These functions are also explained when you select the On-line Help [Help].
- If you want to determine which lines represent which values, then try switching single values on and off.

4 To exit this display, press [Esc].

7.3 Status displays

7.3.1 Display of status/malfunction messages

Function

Call-up `device status – Status/error` to display all current malfunction and status messages of the S700.

Call-up

▶ Select `main menu → device status → status/faults`.

`status/faults`
 	
`Heating up ...`
`FAULT: condensate`
 	
`Back : ESCAPE`
	← The current status messages ...
	←
	←
	←
	←
	← ... are shown here [1]
	
	To exit this display: Press [Esc].

[1] Clarification (in alphabetical order), see "Status messages (in alphabetical order)", page 211

7.3.2 Display of measuring ranges

Function

Using the menu `device status – measuring ranges`, you can see the physical measuring ranges. These settings can only be changed at the factory.

Call-up

1. Select `main menu → device status → measuring ranges`.
2. Select the desired measuring component.

`Measuring ranges`
 	
`H2 80.00 vol.%`
`to 100.00 vol.%`
 	
`Span gas`
`100.00 vol.%`
 	
`Back : ESCAPE`
	← start value of the physical measuring range
	← end value of the physical measuring range
	
	← physical zero point of the related analyzer module
	
	To exit this display: Press [Esc].

- To display the output ranges of the measured value outputs, see "Display of measured value outputs", page 101.
- To set the output ranges, see "Setting-up the output ranges", page 117.

7.3.3 Display of measured value outputs

Function

The `device status – meas. value outputs` display shows which measured values are output via the analog outputs and which output ranges are set-up.

Call-up

1. Select `main menu→ device status→ meas. value outputs`.
2. Select the desired `meas. value output`.

`Measured value output 1`	← meas. value output number
`O2`	← assigned measuring component
`4...20`	← electrical measuring span (output span)
`0.00 - 25.00 vol.%`	← physical meas. range of the meas. component.
`[1] 0.00 - 10.00`	← start and end value for output range 1
`Switch pt.: 10.00`	← switching pt. for auto. range switching 1 → 2
`[2] 0.00 - 25.00`	← start and end value for output range 2
`Switch pt.: 9.50`	← switching pt. for auto. range switching 2 → 1
`active 2`	← current output range
`Back : ESCAPE`	*To exit this display:* Press [Esc].

- Assignment of the measuring components, see “Assigning measuring components”, page 116.
- To set the output ranges, see “Setting-up the output ranges”, page 117.

7.3.4 Display of alarm limit values

Function

The function `device status – alarm settings` displays the alarm settings set; see “Setting alarm limit values”, page 114.

Call-up

▶ Select `main menu → device status → alarm settings`.

`Alarm settings`	
`component ef value`	
`[1] CO2 > 360.00`	← [...] = alarm number
`[2] O2 < 12.75`	← “<” = alarm is given below the limit value
`[3] CO2 > 250.00`	← “>” = alarm is given above the limit value
`[4] Not in use !`	← this alarm limit value is not defined
`Back : ESCAPE`	*To exit this display:* Press [Esc].

7.3.5 Display of device data

Function

The menu `device data` provides the following information:

- individual device identification
- version of internal hardware and software
- built-in analyzer modules

Call-up

▶ Select `main menu→ device status → device data`.

`device data`	
`device name:`	
`S710`	← stored device name
`Device no.:`	
`123456`	← Serial number
`hardware version: 1`	← electronic board version in your analyzer
`software version:1.28`	← version of the software in your analyzer
`sensor type 1-3`	
`MULTOR`	← built-in analyzer module (example)
`OXOR`	← built-in analyzer module (example)
`Back: ESCAPE`	*To exit this display:* Press [Esc].

7.3.6 Display of drift values

Function

The “absolute drifts” represent the total drift over a number of calibrations (not the difference between the last two calibrations).

A new summation of “absolute drifts” will be started

- after a drift reset (see “Drift reset”, page 166)
- after a basic calibration (see “Basic calibration”, page 168).

- After a drift reset or a basic calibration, there are no absolute drifts until a new calibration has been made.
- This also applies to brand-new analyzers where absolute drifts will not appear before a calibration has been made.

“Absolute drifts” refer to the displayed measured values (including linearization, drift compensation, etc.). Zero point drifts are related to the physical measuring span of the relative analyzer module; sensitivity drifts are relative to the nominal value of the test gas used during calibration. Notes on the calculation, see “Displaying calibration data”, page 165.

Call-up

▶ Select `main menu→ device status→ absolute drift`.

`absolute drifts`	
	←
`zero-d span-d`	← “Zero point drift” / “sensitivity drift”
`O2 0.2% -2.3%`	← (example values)
`CO2 -1.0% -1.6%`	←
`NO -0.7% 0.3%`	←
`Back : ESCAPE`	*To exit this display:* Press [Esc].

7.4 Control

7.4.1 Switching the gas pump on/off

Function

This function is used to switch the fitted gas pump (option) and the switching output “external pump” on and off (see “Available switching functions”, page 121).

The gas pump will automatically remain switched off
- as long as the S700 has not reached its operating temperature;
- as long as the fitted condensate sensor (option) triggers;
- when calibration gas is fed, if this is set (see “Setting the nominal values for the calibration gases”, page 159);
- if the control input “gas pump off” is set-up and activated (see “Available control functions”, page 122).

Setting

▶ Select `main menu→ control → gas pump on/off`.

`gas pump on/off`
 	
`Selection: 0=OFF`
`1=ON`
 	
`Status : OFF`
 	
`Input : ■ OFF`
 	
`Save : ENTER`
`Back : ESCAPE`
	To change the status:
	1 Enter either [0] or [1].
	2 Press [Enter].
	3 Press [Esc] to exit this function without any (more) changes.

This menu function is not available when a “service lock” control input is set-up and activated (see “Available control functions”, page 122).

7.4.2 Acknowledging alarms

Function

For safety purposes, some status messages will remain activated even when the initial reason for the message does not exist any more. This applies to:

- Malfunction message of the condensate sensor (option);
- "Alarm" messages, for which this characteristic is activated (see "Setting alarm limit values", page 114).

Notes on the "condensate" malfunction message

A S700 with fitted condensate sensor (option) signals `ERROR: condensate`, when condensate occurs in the internal sample gas path or when a conductive liquid enters the sample gas path of the S700.

It is possible that the condensate is only present for a short time, and after a while the condensate sensor is "dry" again. However, some components of the S700 measuring system might have been damaged by the condensate. This malfunction should always be checked. This is why the S700 does not automatically cancel the message `FAULT: condensate` even if the condensate sensor no longer signals a fault state.

Damage through liquids and corrosion

- When the S700 indicates `FAULT: condensate`, first locate and repair the source of the problem (see page 210).
- Then switch off the fault signal.

Procedure

1. Select `main menu → control → acknowledge`.

»» The status messages which need to be acknowledged will be displayed. There is a code above each status message. A code letter identifies the current status:

Table 11: Code letters for status messages which must be acknowledged

Code	The cause for the status message is ...	The status message is currently ...
–	currently not present	not activated
A	actively present	activated (not acknowledged)
N	currently not present	
Q	actively present	acknowledged and deactivated

Devices with the "sampling point selector" option (see page 142) will display these codes in a Table. This Table represents the sampling points. You can see which sampling point has caused the status message.

To acknowledge a status message:

2 Enter the desired code.
3 Press [Enter].

7.4.3 Setting the display contrast

Function

The contrast setting allows you to adjust the visual impression of the LC display. Just try which setting is best for your location.

Setting

Select `main menu → control → display`.

`Display`
 	
`Unit: value`
`Min. value: 0`
`Max. value: 9`
 	
`Status: 7`
 	
`Input: ■`
`Back: ESCAPE`
	▸ *To change the display contrast:* Select a number key. The display contrast will immediately change.
	▸
	▸ To save the value, press [Enter].
	▸ To exit this function, press [Esc].

This menu function is not available when a “service lock” control input is set-up and activated (see “Available control functions”, page 122).

7.4.4 Setting the keypad click

Function

The S700 can give an acoustic signal on each keypad entry. The length of the tone is adjustable, which allows you to adjust the intensity. To disable the tone, set the status value to “0”.

Setting

Select `main menu → control → keypad click`.

`keypad click`
 	
`Unit: value`
`Min. value: 0`
`Max. value: 20`
 	
`Status: 7`
 	
`Input: ■`
`Back: ESCAPE`
	▸ *To change the status:* Enter the desired value and press [Enter].
	▸ To exit this function, press [Esc].

This menu function is not available when a “service lock” control input is set-up and activated (see “Available control functions”, page 122).

7.5 Calibration (note)

The `calibration` function allows you to

- start or perform calibration procedures
- check the stored calibration parameters
- check the starting time of the next automatic calibration (if set).

These functions are explained in a separate Section (see “Calibration”, page 146).

7.6 Activating the maintenance signal

Function

The status output “Service” ((see “Available switching functions”, page 121)) can be activated per menu function. This can be used as a signal message to an external location to indicate that the S700 is not working in regular measuring mode, for example, because maintenance is currently being carried out.

Setting

`Main menu`
 	
`1 measuring display`
`2 device status`
`3 control`
`4 calibration`
`5 maintenance signal`
	1 *If the* `main menu` *is not displayed:* Press [Esc] repeatedly until the `main menu` appears.
	
	2 Select `maintenance signal`.

`Maintenance signal`
 	
`Selection: 0=OFF`
`1=ON`
 	
`Status : OFF`
 	
`Input : ■ OFF`
 	
`Save : ENTER`
`Back : ESCAPE`
	▸ *To change the status:* Enter “0” or “1” and press [Enter].
	
	▸ *To exit this function without any (more) changes:* Press [Esc].

- This menu function is not available when a “service lock” control input is set-up and activated. This menu function can also be interrupted by switching the “service lock” (see “Available control functions”, page 122).
- Please do not forget to switch off the maintenance signal when it is no longer required.

8 Expert functions

8.1 Access to the expert functions

Do the following to access the expert functions:

Display	**Operating step / notes**
Any menu	▶ Press [Esc] as often as required until the `main menu` is displayed.

`Main menu`
 	
`1 measuring display`
`2 device status`
`3 control`
`4 calibration`
`5 maintenance signal`
	▶ Press the decimal point key [.]
	After that ...

`Main menu`
 	
`1 measuring display`
`2 device status`
`3 control`
`4 calibration`
`5 maintenance signal`
`6 settings`
`7 service`
	... `the menu items` 6 `and` 7 are available.
	
	▶ *To fade out the expert functions:* Press the decimal point key [.] again.

When you call-up `settings` or `service`, a warning message is displayed:

▶ Read the warning message and consider it.
▶ Press [Enter] to proceed.

If a “Service lock” control input is set-up and activated, then only menu items `1` and `2` are available in the `main menu` (see “Available control functions”, page 122).

8.2 Hidden expert functions

Some of the expert functions are located in menu branch 69. However, menu item 9 is not shown in the `settings` menu. To access the expert functions in menu branch 69:

1. Call up the `settings` menu (see “Access to the expert functions”).
2 Press the [9] key.
3 Enter this `Code`: [7] [2] [7] [5] [Enter]

After that, menu 69 is displayed, with all its functions available.

8.3 Local adaptation (localization)

8.3.1 Language setting

Function

The S700 can display the menu texts and “Help” information in different languages. You can change the language at any time. Call-up the selection menu to see the languages available.

Setting

1. Call-up menu 66 (`main menu → settings → language`).
2 Select the desired language from the displayed list.

8.3.2 Setting the internal clock

Time

1. Call-up menu 611 (`main menu → settings→ clock → time`).
2 Enter the current time and press [Enter]. When you press the key, the internal clock starts with the entered time and `:00` seconds.

Please also check the summer time/standard time setting.

Date

1. Call-up menu 612 (`main menu → settings → clock → date`).
2 Enter the current date and press [Enter].

Summer time or standard time

The changeover from daylight saving time to standard time is not automatic, but must be done manually.

1. Call-up menu 613 (`main menu → settings → clock → std./summer time`).
2 Select `standard time` or `summer time` and press [Enter].

With summer time, the clock is set one hour forwards. – Example: Std. time 18:00 = summer time 19:00.

Time format

The internal clock can be set to display either in European 24-hour format (`00.00` to `23.59`) or in American `am/pm` format.

1. Call-up menu 614 (`main menu → settings → clock → time format`).
2 Input the desired setting and press [Enter].

Date format

The date can be displayed in European format (day.month.year) or in American format (month-day-year).

1. Call-up menu 615 (`main menu → settings → clock → date format`).
2 Input the desired setting and press [Enter].

8.4 Display of measured values

8.4.1 Select number of decimal places

Function

A maximum of five characters can be used to display a measured value. If the measured value includes decimal places, you can select the desired number of decimal places. The selection range depends on the number format of the physical measuring range end value.

- If the measured value display includes 4 or 5 characters, then the measured value display is more accurate than the real measuring precision. Moreover, the last digits might permanently fluctuate even when the measured value should be seen as constant (within the limits of the measuring precision/signal “noise”). This effect can be influenced by “damping”; see “Setting damping (rolling average value computation)”, page 111.
- If you limit the number of decimal places so that the measured value display only contains 2 or 3 numbers, then you might possibly not be able to notice slow measured value shifts in time.

Setting

1. Call up menu 623 (`Main menu → Settings → Measurement → Meas. value display`).
2 Select for which measuring component the setting should be made.
3 Select `decimal places`.
4 Set the desired number of decimal places (select anywhere between `min.value` / `max.value`).

8.4.2 Bar graph range selection

Function

You can select whether the “bargraph” display (see page 97) represents the physical measuring range of the related measuring component or the current output range of the associated measured value output (see “Selecting the output ranges”, page 118).

Setting

1. Call up menu 623 (`Main menu → Settings → Measurement → Meas. value display`).
2 Select for which measuring component the setting should be made.
3 Select `bargraph range`.
4 Select `phys. meas. range` or `output range`.

8.5 Measured value computation

8.5.1 Setting damping (rolling average value computation)

Function

The S700 updates the measured value displays and outputs in periods of approx. 0.5 to 20 seconds. In some applications, this may cause some problems:

- Rapid changes in the gas concentration will cause “leaps” between the single measured values.
- If the current gas concentration fluctuates around an average value, this will produce many different measured values. However, you may want to see the average value.

You can reduce these effects by setting a “damping” value. When you set-up this, the S700 will not display the current measured values, but averages of the current and the previous values (floating averaging).

- You can set the damping for each measuring component individually, e.g in order to optimize the setting for each analyzer module.
- The damping effects both the display and the measured value output signal.
- The damping is also effective during calibration.

- Increasing the damping value will probably increase the response time (T90 time) of the gas analysis system.
- Decreasing the damping can increase the “noise” of the measuring signal (measuring turbulence).
- The response time of the gas analyzer also depends on gas-technical factors (length of the sample gas path, volume of upstream filters, etc.) and cannot be reduced at random.

“Dynamic damping” can be used to compensate for measured value fluctuations without increasing the response time significantly; see “Setting dynamic damping”, page 112.

Setting

CAUTION: Risk for connected devices/systems
If the damping is changed during measuring operation, it could be that the measured values make a rapid change at once.
▶ Make sure that this situation cannot cause problems on connected devices.

1. Call-up menu 624 (`main menu → settings → measurement → damping`).
2. Select for which measuring component the setting should be made.
3. Set the desired time constant.

CAUTION: Risk of wrong calibration
The calibration measuring time should be at least 150 ... 200% of the programmed damping time constant.
▶ *When damping has been set anew or increased:* Check whether the calibration measuring interval needs to be adjusted; see “Setting the calibration measuring interval”, page 162.

8.5.2 Setting dynamic damping

Function

Contrary to normal damping (see page 111), “dynamic damping” is automatically deactivated when the measured value changes rapidly. This allows “smoothing“ continuous *minor* fluctuations of the measured value, while having an instant response when the measured value is *rapidly* changing.

This dynamic behavior is controlled with the response threshold: With dynamic damping, the S700 continuously checks the difference between two consecutive measured values from the internal measured value processing; dynamic damping is then deactivated when the difference is larger than the response threshold. The result is:

– If the differences continue to be greater than the response threshold (which means that the measured values are still changing rapidly), the dynamic damping will fade out – after the selected damping time constant has run down, the damping effect is completely off and does not slow down the response time any longer.
– As soon as the measured value differences come down and remain below the response threshold (which means that the measured value changes are small and slow), the dynamic damping will gradually come back into operation.

Functional features

- The time constants of the damping and response threshold are individually adjustable for each measuring component.
- The response threshold is always relative to the measuring span of the current output range of the corresponding measured value output.
- The dynamic damping effects the measured value output signal and the displayed measured values.
- Dynamic damping is also effective during calibration.

Setting the time constant

1. Call up menu 6971 (`main menu → settings → [9] → [code] → dyn. damping → time constant`).
2 Select for which measuring component the setting should be made.
3 Set the desired time constant (1 ... 120 s).

Setting the response threshold

1. Call-up menu 6972 (`main menu → settings → [9] → [code] → dyn. damping → dyn. threshold`).
2 Select for which measuring component the setting should be made.
3 Set the desired threshold value. – Setting range: 0.0 ... 10.0% of the measurement span of the output range. 0.0 = dynamic damping off (deselected).

CAUTION: Risk of wrong calibration
The calibration measuring time should be at least 150 ... 200% of the programmed damping time constant.
▶ *When damping has been set anew or increased:* Check whether the calibration measuring interval needs to be adjusted (see page 162).

8.5.3 Suppressing measured values at the start of the measuring range

Function

All measured values close to the start value of the physical measuring range can be displayed as " 0 " (or as the respective measuring range start value). This then "masks" measuring fluctuations at the zero point, for example, to suppress the display of negative measured values, or to "turn down" the connected controls to zero in case of very small measured values. Hidden ranges can be set:

- separately for a range above and below the physical start value of the range
- individually for each measuring component

The possible "masking" range is 10 % of the physical measuring range. Masked ranges are effective for all measured value displays concerned, i.e. for

– measured values on the display
– measured value output signals
– digital measured value outputs via interface

CAUTION: Risk of undesired effects on connected devices/systems

- *With measured value masks:* The measured value displayed does not usually match the actual measured value in masked out display ranges. As soon as the true measured value leaves the masked range, the displayed measured values will suddenly change from the "masked" to the current measured value. A similar effect will happen in reverse direction. If an external controller is connected, these effects should be considered.
- *Without measured value masks:* The measured value display follows the measuring signals consequently even at the start of the physical measuring range. Due to the limited measuring precision, small *negative* measured values could also be displayed. (This does not apply to the analog measured value outputs which cannot produce negative signals.)

▶ Consider the effect of measuring signal masks on connected devices.

Einstellung

1. Call-up menu 692 (`main menu` → `settings` → `[9]` → [code] → `meas. sig. window`).
2 Select the `meas. component` for which this following settings should apply.
3 Select `neg. window` or `pos. window`.
4 Set the end value of the masked range. (The start value of the masked range is identical to the start value of the physical measuring range).

8.6 Monitoring measured values

8.6.1 Setting alarm limit values

Function

You can set four limit values to monitor the measured values. The associated “Alarm” signal can be triggered when the measured value is above or below the limit value. You can also decide whether the “Alarm” signal remains activated - independent of the measured value development - until the “Alarm” signal is “acknowledged”; see “Acknowledging alarms”, page 105.

When the measured value exceeds a programmed limit value

- LED “Alarm” on the front of the S700 is on;
- Message appears on the display, for example. `CO2 > 250.00 ppm`;
- Related “Alarm” status output is activated (see “Available switching functions”, page 121) .

For an overview of alarm limit values set, see `main menu → device status → alarm settings`.

Setting

1. Call-up menu 622 (`main menu → settings → measurement → alarm settings`).
2 Select the desired `alarm limit value` (`1 ... 4`).
3 Make the following settings:

`Measuring component`	The measuring component for which the following settings will be valid
`Set point`	Limit value in physical (engineering) units

`Effect`	`Higher` = “Alarm” triggered when the measured value is higher than the `limit value`
	`Lower` = “Alarm” triggered when the measure value is lower than the `limit value`
	`off` = the limit value is deactivated (settings are kept, but have no effect)

`Acknowledge`	`Off` = “Alarm” message disappears as soon as the measured value is within the limit value. `On` = “Alarm” message remains until “acknowledged” with a menu function (see “Acknowledging alarms”, page 105).

8.6.2 Activating warnings of working range limits (overflow warnings)

Function

The S700 will create a malfunction message,

- when a measured value is larger than 120 % of the end value of the related physical measuring range;
- when an internal measuring signal exceeds the limits of the internal measured value processing.

Connected devices could consider this status message as a failure of the gas analyzer. In this case, the gas analyzer would appear as if failed even though it is functioning perfectly and the real reason is the high measured values. To avoid this wrong interpretation, you can disable these automatic malfunction messages.

Procedure

1. Call-up menu 693 (`main menu → settings → [9]` → [code] → `meas. signal effect`).
2. Select the desired function:

`no over range al.`	... refers to the malfunction message created when a measured value exceeds 120 % of the physical measuring range (measured value warning)
`no overflow alarm`	... refers to the malfunction message created when a measured value exceeds the internal processing range (overflow warning)

3. Now select the desired mode for this function:

OFF	automatic warning is activated (= standard setting)
ON	automatic warning is deactivated

8.7 Configuring calibration (note)

For information on menu branch 63 (`main menu → settings → calibration`) please refer to Automatic calibrations", (see page 156).

8.8 Configuration of measured value outputs

A measured value output must be assigned to a particular measuring component before you can make all the other associated settings.

8.8.1 Special functions for certain sampling point configurations

If the S700

- has the option “Sampling point selector (see page 142)
- *and* measures only one measuring component
- *and* the number of sampling points has been set to 1, 2, 3 or 4

then

- each measured value output will automatically represent one of the sampling points and will constantly display the last measured value of its assigned sampling point, as long as the other sampling points are measured (“sample-hold” function)
- settings for measured value output 1 are automatically valid for the remaining measured value outputs; deviating settings for measured value outputs 2, 3 and 4 are not possible.

In all other cases, the measured value output will constantly display the current measured value of its assigned measuring component.

8.8.2 Assigning measuring components

Function

Each measured value output can be assigned to one of the measuring components. You can also assign one certain measuring component to several measured value outputs.

Notice: To change an existing assignment, first delete the remaining settings of the related measured value output. Otherwise your selection will have no effect.

Setting

1. *To change an existing assignment:* Delete all the settings for the related measured value output (see page 119).
2. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
3. Select the desired `meas. value output`.
4. Call-up `meas. component`.
5. Select the desired measuring component from the list displayed.
   The selected component is indicated by `>`.

8.8.3 Setting-up the output ranges

Function

The output ranges for the measured value outputs have been set-up at the factory, but can be modified.

With the option “second output range”, each measured value output can have two output ranges which can be independently set. Please note:

- The difference between the start and end value of an output range must be at least 10 % of the physical measuring range end value. This limitation is automatically set in the related setting menus.
- The output ranges must logically overlap. A “gap” between the output ranges is not allowed.
- These settings can not change the physical measuring range.
- Output range 2 should correspond to the physical measuring range.

Setting

1. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
2. Select the desired `meas. value output`.
3. Select `output range 1` or `output range 2`.
4. Set the following values:

`begin value`	Physical start value for this output range
`end value`	Physical end value for this output range
`Switching point` [1]	`switch-up value` = the measured value where the analyzer should switch from output range 1 to output range 2. Usually this is the same value as the end value of this output range. But you can also select any value within the displayed `Min./Max.` range.
	`switch-down value` = the measured value where the analyzer should switch from output range 2 to output range 1. The `switch-down value` must be *smaller* than the switch-up value. Set-up this value in such a way that the difference between the `switch-up value` and the `switch-down value` is significantly larger than the specified measuring precision of the S700.

[1] Only for devices with the option “Second output range”.

▶ Do not set-up identical switching points.
Otherwise the S700 would permanently be switching between the output ranges when the measured value is at the switching point.

- Standard value for the difference in switching points: 2 % of the relevant physical measuring range.
- Set-up a greater difference between the switching points if the measured values can be expected to be fluctuating or “noisy”.

8.8.4 Displaying the output ranges

To display the output ranges for each measured value output:

1. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
2 Select the desired `meas. value output`.
3 Call-up `output range list`.

8.8.5 Selecting the output ranges

Only for devices with option “Second output range”.

Function

There are three modes of output range selection for each measured value output:

- Fixed setting of the desired output range
- Internal automatic range switching (switching points, see “Setting-up the output ranges”, page 117)
- External range control via control input; (see “Available control functions”, page 122)

Setting

1. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
2 Select the desired `meas. value output`.
3 Call-up `range selection`.
4 Select the desired mode:

`Output range 1`	Output range is fixed
`Output range 2`	
`auto. switching`	Internal automatic range switching
`ext. switching`	External range selection via control input

- The numerical measured value display on the display will not be affected by the output range selection.
- The bar graph display of the measured values can be set-up to represent either the physical measuring range or the current output range; see “Bar graph range selection”, page 110.

8.8.6 Setting the “live zero”/deactivating a measured value output

Function

Each measured value output can be programmed to represent the measured values within the range 0 ... 20 mA, 2 ... 20 mA, or 4 ... 20 mA. When a “live zero” is selected (2 mA or 4 mA), the electronic signal “0 mA” can be interpreted as an general fault condition or electrical disconnection.

You can also deactivate each measured value output: The measured value output remains at “0 mA” in this case.

Setting

1. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
2 Select the desired `meas. value output`.
3 Call-up `live zero (mA)`.
4 Select the desired electrical zero point for this measured value output or select `no output`.

8.8.7 Selecting the output mode during calibration

Function

During a calibration, the measured value outputs can function in two different modes:

- Constant output of the measured value that was last measured before the calibration started (in the last selected output range).
- The measured value output outputs the measuring signals generated during test gas feed. In this mode, the measured value output displays “raw values” without any compensation; thus, the calibration gas values can be registered in a “raw state” to determine the “absolute drift”. The measured values shown on the display do not exactly correspond to these output signals.

Setting

1. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
2 Select the desired `meas. value output`.
3 Call-up `output assignment`.
4 Select the desired mode during calibration:

`Calibration values`	Output of the current calibration gas values (output range 2)
`hold meas. value`	Constant output of the last measured value

8.8.8 Deleting the setting for a measured value output

Function

This menu allows to delete all of the settings for a measured value output. After you have deleted the settings, the measured value output will constantly display 0 % (0 mA).

For a short-time shut off of a measured value output, set “no output” for the live zero (see “Setting the “live zero”/deactivating a measured value output”, page 118). In this way, all the other measured value output settings would be kept.

Setting

1. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
2 Select the desired `meas. value output`.
3 Call-up `delete config.`

8.9 Configuration of the switching outputs

8.9.1 Functional principle

You can assign each of the configurable switching outputs (REL4 ... REL8 and TR1 ... TR8 see “Switching outputs”, page 70) to any of the available control functions (see “Available switching functions”, page 121).

The same control function can be assigned to multiple switching outputs – for example, for two separate switch contacts for the same switching operation.

8.9.2 Control logic

Switch logic (make contact / break contact)

The relay switch contacts allow you to connect the external switching function to a make contact or a break contact. Use this feature in combination with the activation logic to find the appropriate control logic for your system.

Activation logic (open-circuit/closed-circuit principle)

Once you have assigned a control function to a switching output, you have two possibilities:

- *Normal switching logic (open-circuit principle):* In this case, the switching output is electronically activated (relay activated, transistor output conducts current) when the assigned switching function is logically in the activated state.
- *Reversed switching logic (closed-circuit principle):* The switching output is activated electronically when the assigned switching function is *not* logically activated. When the function is logically activated, then the switching output is in the electronically inactive state (relay is passive, transistor output blocks current).

8.9.3 Safety criteria

CAUTION: Risk for connected devices/systems

- ▶ Before using the switching outputs, clarify the safety-relevant consequences for the following operational problems:
  - Power failure on the S700 (for example, local power failure, or accidental switching-off, or defective fuses)
  - Defect in the S700 (for example, electronic defect of a switching output)
  - Interruption of the electrical connection
- ▶ Observe the switching method:
  - Switching outputs which operate according to the *open-circuit* principle will show the assigned function as being *non active*, when a power failure occurs.
  - Switching outputs which operate according to the *closed-circuit* principle will immediately signal the assigned function as being *active*, when a power failure occurs.
- ▶ Carefully review the consequences. Make sure that no dangerous situation can be created when a failure or defect occurs.

8.9.4 Available switching functions

Control signals

Function name	x	Function (when activated)
Zero gas path x	1 ... 2	The matching gas should be fed.
Test gas path x	1 ... 4	"Zero gas path 1" is activated when the calibration cuvette is active (see "Calibration cuvette for analyzer modules UNOR and MULTOR", page 29).
Sample gas path		
External pump		Switch on the external sample gas pump.
switch on pt. x	1 ... 8	Activate sampling point x (see "Sampling point selector (option)", page 142).

Status signals

Function name	x	Meaning (when activated)
failure [1]		Internal fault or defect. At the same time, "Function" is red and an error message displayed (see "Status messages (in alphabetical order)", page 211). -*Attention:* This switching output is activated when *no* malfunction is present - closed circuit principle.
service [2]		A calibration is running, or the "maintenance signal" has been activated, see "Activating the maintenance signal", page 107 or a function in menu level 6 or 7 has been called up[3]. – Corresponds to the NAMUR status signal "function monitoring".
fault [4]		Certain internal limit values are slightly exceeded. At the same time, "Service" goes on and a SERVICE message displayed. This function corresponds to the status signal "service required" as defined by the NAMUR requirements. – The cause for this signal does not yet reduce the S700 measuring ability, however a technician should correct the problem soon.
alarm limit x	1 ... 4	Alarm limit value exceeded or underflown (see "Setting alarm limit values", page 114).
calibration active		Calibration is running.
auto. calibration		Automatic calibration is running.
output x	1 ... 4	Measured value output x works in output range 1. Not available for special version "THERMOR 3K" (see "Special version "THERMOR 3K"", page 222).
meas value pt. x	1 ... 8	Current meas. values relate to sampling point x (see "Sampling point selector (option)", page 142).[5]
FAILURE sensor x	1 ... 3	Analyzer module x is not operational, explanation, see "FAILURE sensor x", page 209.[6]
SERVICE sensor x	1 ... 3	Current measured values from analyzer module x might be wrong (explanation see "SERVICE: Sensor x", page 213). [6]
CALIBR. sensor x	1 ... 3	Calibration is running with analyzer module x.
FAILURE extern x	1 ... 2	The input signal on analog input INx (see "Analog inputs", page 69) is too high (exceeds the tolerance) or signal processing in S700 is faulty because internal processing limits are exceeded. The corresponding displayed measured value is unusable (probably wrong).
SERVICE extern x	1 ... 2	The input signal on analog input INx (see "Analog inputs", page 69) is close to the upper tolerance limit or processing in S700 is approaching the internal processing limits. The corresponding displayed measured value is still correct.
CALIBR. extern x	1 ... 2	A calibration is running with the measuring component which represents the measuring signal from analog input INx (see "Analog inputs", page 69). [6]
Flow sensor		The gas flow in the internal sample gas path is less than 50 % of the programmed limit value (see "Setting the flow monitor limit value", page 137).
Condensate sensor		Condensate is present in the internal sample gas path of the S700 (corresponds to status message "FAULT Condensate" see "FAULT: condensate", page 210).
meas.value output x	1 ... 3	*Only for special.version "THERMOR 3K":* Measured value output active (see "Special features of the special version "THERMOR 3K"", page 223).

[1]This function is permanently assigned to switching output REL1. If required, this function can also be assigned to other switching outputs.

[2]Is permanently assigned to switching output REL2. If required, this function can also be assigned to other switching outputs.

[3]Some of these menus will interrupt the S700 measuring function. Therefore usage of these menu branches automatically activates the maintenance signal.

[4]Is permanently assigned to switching output REL3. If required, this function can also be assigned to other switching outputs.

[5]After activating the next sampling point, a "dead time" will run down before the new status is indicated, see "Configuring the sampling point selector", page 143.

[6]Display of built-in analyzer modules, see "Display of device data", page 102.

8.9.5 Assigning the switch functions

1. Call-up menu 691 (`main menu → settings → [9] →` [code] `→ signal assignment`).
2 Select a category:

`Relay outputs`	= switching outputs REL4 ... REL8
`Transistor outputs`	= switching outputs TR1 ... TR8

3 Select the desired switching output.
4 Enter the code of the desired switch function. You can find the codes in the help information menu (press [Help]).
5 To reverse the switching function logic: Press [–] [Enter]. (In the display, reverse logic is symbolized with " ! ")

Use User Table: Switching outputs", (see page 236) for planning and documentation.

8.10 Configuration of the control inputs

8.10.1 Functional principle

Each of control inputs CI1 ... CI8 (see "Control inputs", page 73) can be assigned to any of the predefined software control functions (see "Available control functions").

8.10.2 Available control functions

Internal controls

Function name	x	Function (when input is activated)
service block		Reduces the main menu to functions "Measuring display" and "Device status". Settings and calibrations cannot be made. A running calibration is terminated. – Corresponds to the NAMUR control input function "Communication".
pump on/off		Deactivates the fitted gas pump (if existing and activated via menu function; see "Switching the gas pump on/off", page 104).
output x	1 ... 4	Output range 1 is selected for measured value output x (deactivated status means output range 2).*Attention:* Only effective as long as "External switching" is selected for the measured value output; see "Selecting the output ranges", page 118.
	1 ... 3	Only for THERMOR 3K: Measured value output/measuring component is activated (detailed information, see "Special features of the special version "THERMOR 3K"", page 223)
hold sample pt. x	1 ... 8	Sampling point x is activated (see "Sampling point selector (option)", page 142). When several control inputs of this type are activated at the same time, then the first sampling point will be activated.[1] "Switch off pt. x" will have no influence.
switch off pt. x	1 ... 8	Sampling point x is skipped when automatic switching is active (see "Sampling point selector (option)", page 142). Can be activated for several sampling points.[1]
no drifts		Drift compensation is deactivated (means that the measured values will be calculated on the basis of the last basic calibration). Applies to all displayed measured values and measured value outputs.
sample value hold		All measured value outputs remain constant at the value present when this function was activated ("Sample hold" function).
auto.cal. x start	1 ... 4	Starts automatic calibration x (see "Automatic calibrations", page 156). This function is triggered when switching from deactivated to activated state; maintaining the activated state does not trigger any further calibrations. – These control functions can be deactivated; see "Ignoring an external calibration signal", page 161.
cal. stop		Interrupts a running automatic calibration.

[1]Has priority over automatic sampling point selection (see "Configuring the sampling point selector", page 143).

External status signals

Function name	x	Function (when input is activated)
zero gas x fault	1 … 2	If at least one of these inputs is activated, automatic calibrations will not be started, running calibrations will immediately be terminated, “Service” goes on and switching output “Malfunction” activated. For example, devices which monitor the pressure in calibration gas cylinders can be connected to these inputs.
test gas x fault	1 … 4	
failure x	1 … 2	These inputs can be used to connect external status signals. When the input is activated, the related status message is shown on the display (see “Status messages (in alphabetical order)”, page 211) and, if necessary, output via interface (see “Output of digital measured data”, page 125) and the related status output activated (if set up; see “Available switching functions”, page 121).
fault x		
service x		

- The logic of each control function can be reversed; see “Assigning control functions”, page 123.
- Use User Table: Control inputs”, (see page 237) for planning and documentation.

8.10.3 Assigning control functions

1. Call-up menu 6911 (`main menu → settings, → [9]` → [code] → `signal assignment → signal inputs`).
2. Select the desired control input.
3. Enter the code of the desired control function. You can find the codes in the help information menu (press [Help]).
4. To reverse the switching function logic: Press [–] [Enter]. In the display, reverse switching logic is symbolized with “ ! ”.

- The settings can be noted in a Table see “User Table: Control inputs”, page 237.
- Call up the current status to display an overview of the programmed control inputs; see “Status of the control inputs”, page 141.

8.11 Digital data transmission

8.11.1 Digital interface parameters

Function

These functions are used to set-up the parameters of the digital interfaces (connection, see “Digital interfaces”, page 76). Data communication will only work when the interface parameters of all connected instruments are identical.

Setting

1. Call-up menu 64 (`main menu → settings → interfaces`).
2 Select `serial inter. #1` or `serial inter. #2`.
3 Check/adjust the following settings:

`Baud rate`	Data transmission speed of the interface. Select the highest value that the connected instruments will allow. Standard setting: `9600`
`Parity`	The parity bit (if used) monitors the character transfer. Standard for communication with PCs: `no parity`
`Data bits`	S700 only uses characters from the 7-bit range (ASCII code range 0 ... 127), but can also communicate in the 8-bit format. Standard for communication with PCs: `8 bit format`
`CR signal`	This function determines which characters the S700 sends at the end of a data line `CR` = Carriage Return; `LF` = Line Feed). Standard for output on PC printers: `CR LF`
RTS/CTS protocol	The RTS/CTS protocol is a hardware handshake procedure between sending (S700) and receiving unit, via the interface connections RTS (Ready To Send) and CTS (Clear To Send). ▶ Observe the notes on RTS/CTS protocol when operating with BUS converters → see “Setting interface parameters (overview)”, page 190.
XON/XOFF protocol	The XON/XOFF protocol is a software handshake procedure where the S700 reacts to the XOFF and XON codes (received via the RXD connection). After switching the analyzer on or after a power failure, the `XON/XOFF protocol` is activated.

- To test the data output; see “Testing electronic outputs (hardware test)”, page 144.
- If the data transmission does not work even when all the interface parameters match, try a lower baud rate (on all connected devices).
- If the interface still does not work even at the lowest baud rate, check the electrical connections.

8.11.2 Output of digital measured data

Function

You can select which data the S700 will automatically transmit via interface #2 (hardware information, see “Digital interfaces”, page 76).

Settings

1. Call-up menu 644 (`main menu → settings → interfaces → auto. reports #2`).
2. Activate or deactivate the desired data output:

`Measured values`	• Set the time interval in which the S700 automatically outputs measured values (`1 ... 600` seconds). • If you do not want any measured values to be output, set `0` seconds.
status messages	`ON` = the S700 sends every status change with a describing text message (see page 126).
`calib. results`	`ON` = after every calibration, the S700 sends the measured values of the test gases and the calculated calibration values.
`half hour average`	`ON` = on every full and half hour (controlled by the internal clock), the S700 sends the average of the measured values for all measuring components, taken over the last 30 minutes.

Data output format

Measured values (example)

```
#MS 18.01.00 13: 46: 06  #6: 18.98 vol.% O2    883.6 ppm CO2   162.96 mg/m3 NO
```

```
#MS                      = header for the measured value output
18.01.00 13:46:06        = actual date / time
#6                       = number of current sampling point (option; see “Sampling point selector (option)”, page 142)
18.98 vol.% O2  etc.     = measured value for measuring component 1, 2, 3, ...
```

Status messages (example)

```
#AL 18.01.00 13:43:11  01 ON  calibration/maintenance
```

```
#AL                      = header for the status messages
18.01.00 13:43:11        = actual date / time
01                       = message number
ON                       = status has been activated (OFF = deactivated)
Calibration/maintenance = relevant status (see page 126)
```

Calibration results (example 1)

```
#Kx 18.01.00 13:43:10  SO2     200.00  201.37
#Ky ...
```

```
#KN1 ... #KN2            = calibration data for the zero gases
#KP3 ... #KP6            = calibration data for the test gases
18.01.00 13:43:10        = actual date / time
SO2                      = respective measuring component
200.00  201.37           = nominal value, measured value
```

Calibration results (example 2)

```
#NE 18.01.00 13:46:00  SO2       -0.81%   -0.17%
```

```
#NE                      = header for zero point and sensitivity drift
18.01.00 13:46:00        = actual date / time
-0.81%   -2.17%          = zero point drift / sensitivity drift (see “Display of drift values”, page 103)
```

Half hour averages (example)

```
#HM 18.01.00 14:30:00   19.51   125.44   203.52
```

```
#HM                      = header for half hour averages
18.01.00 14:30:00        = actual date / time
19.51   125.44   203.52  = half hour average value for measuring component 1/2/3
```

Possible status messages via interface #2

Message text
calibration/maintenance
Heating... 1
Heating... 2
Heating... 3
FAULT: temperature 1
FAULT: temperature 2
FAULT: temperature 3
start control 4
FAULT: control 4
FAULT: signal #1
FAULT: signal #2
FAULT: signal #3
FAULT: signal #4
FAULT: signal #5
FAULT: electronic
FAULT: overrange #1
FAULT: overrange #2
FAULT: overrange #3
FAULT: overrange #4
FAULT: overrange #5
calibration active
auto. calibration active
Sample gas
Zero gas 1
Zero gas 2
Test gas 3
Test gas 4
Test gas 5
Test gas 6
Measured value output 1: output range 1
Measured value output 2: output range 1
Measured value output 3: output range 1
Measured value output 4: output range 1
external pump
SERVICE: zero drift #1
SERVICE: zero drift #2
SERVICE: zero drift #3
SERVICE: zero drift #4
SERVICE: zero drift #5
SERVICE: sensitivity drift #1
SERVICE: sensitivity drift #2
SERVICE: sensitivity drift #3
SERVICE: sensitivity drift #4
SERVICE: sensitivity drift #5
FAULT: zero drift #1
FAULT: zero drift #2
FAULT: zero drift #3
FAULT: zero drift #4
FAULT: zero drift #5
FAULT: sensitivity drift #1
FAULT: sensitivity drift #2
FAULT: sensitivity drift #3
FAULT: sensitivity drift #4
FAULT: sensitivity drift #5
FAULT: pressure signal

Message text
FAULT: condensate
FAULT: flow signal
SERVICE: Flow
FAULT: Flow
FAULT: zero gas 1
FAULT: zero gas 2
FAULT: test gas 3
FAULT: test gas 4
FAULT: test gas 5
FAULT: test gas 6
FAULT: IR source
FAULT: chopper
FAULT: filter wheel
FAULT: cal. cuvette
FAULT: internal voltages
FAILURE external message 1
FAILURE external message 2
Interruption ext. message 1
Interruption ext. message 2
Service external message 1
Service external message 2
Common alarm failure
Common alarm interruption
SOV sample pt. 1
SOV sample pt. 2
SOV sample pt. 3
SOV sample pt. 4
SOV sample pt. 5
SOV sample pt. 6
SOV sample pt. 7
SOV sample pt. 8
pt. 1 value available
pt. 2 value available
pt. 3 value available
pt. 4 value available
pt. 5 value available
pt. 6 value available
pt. 7 value available
pt. 8 value available
FAILURE: sensor 1
FAILURE: sensor 2
FAILURE: sensor 3
FAILURE: sensor extern 1
FAILURE: sensor extern 2
SERVICE: sensor 1
SERVICE: sensor 2
SERVICE: sensor 3
FAILURE: sensor extern 1
FAILURE: sensor extern 2
CALIBRATION: sensor 1
CALIBRATION: sensor 2
CALIBRATION: sensor 3
CALIBRATION: sensor extern 1
CALIBRATION: sensor extern 2

8.11.3 Printing the internal configuration

Function

You can output the S700 configuration as a plain ASCII text Table, using serial interface #1 or #2 – for example, on a printer.

The data is divided into the `config.` and `config. 2` sections (see Fig. 27). The data are output in the selected menu language (exception: Output in English when Polish selected) .

Making data backups, see “Data backup”, page 132

Call-up

1. Call-up menu 71 (`main menu → service → check values`).
2. Call-up `print config.` (menu 714) or `print config. 2` (menu 715).
3. To start the output, select `serial inter. #1` or `serial inter. #2`.

Fig. 27: Data output “print config.” and “print config. 2” (examples)

```
S 700 configuration from 17.12.02 13:16:21
==========================================

Program version     :  V. 1.26 from 17.12.2002
serial number       :              710790   (79211)
Release date        :            01.01.00
Device name         :               S 710
Housing type        :                 710
Hardware version    :                   2
Language            :             English

  options, hardware
Calibration cuvette  :                OFF   (41117)
Internal pump        :                OFF   (79223)
Pressure sensor      :                 ON   (79221)
Condensate sensor    :                 ON   (79224)
Flow sensor :                          ON   (79222)

  options, software
Remote control, AK :                  OFF   (79235)
Sampling point selector  :             ON   (79236)
Measuring components     :   SO2        CO        CO2        O2    Temp. C
2nd output range :          OFF       OFF        OFF       OFF       OFF
Range ratio > 10:1  :       OFF       OFF        OFF       OFF       OFF
Compensation        :        ON        ON         ON        ON        ON

Flow sensor         :                  20   (79222)
Gas pump on/off  :                     OFF   (31)
Pump capacity       :                   50   (651)
Step motor 0-Pt:                        93   (792481)
Step motor offset:                     144   (792482)
Lamp current     :                     590   (79246)
2 source symmetry :                    590   (79247)

Measuring components    :   SO2        CO        CO2        O2    Temp. C
Measurement compensation :    3         3          3         3         3
a                  : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
b                  : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
c                  : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
d                  : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
e                  : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
f                  : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
SO2                :        OFF        No        OFF       OFF       OFF
CO                 :         No       OFF         No       OFF       OFF
CO2                :        OFF       OFF        OFF        No       OFF
O2                 :        OFF       OFF        OFF       OFF       OFF
Temp. C            :        OFF       OFF         No       OFF       OFF

Temp. corr.   :              ON        ON         ON        ON        ON
Phys. unit    :             ppm      vol.%      vol.%     vol.%
Phys. start value :          0.0    0.0000      0.000     0.000      0.00
Phys. end value     :     5000.0    5.0000     25.000    25.000    600.00
Span gas      :             0.0    0.0000      0.000     0.000      0.00
Phase               :      70.0      70.0      246.0      70.0      70.0
pressure coeff.   :       1.079     0.684      1.477     1.090     0.000

Sensor plug     :        X 18      X 18       X 18      X 19   External 1
Sensor type       :      Multor    Multor     Multor  Oxor (DC)        ---
```

```
output range 1
Start value         :         0.0      0.0000       0.000       0.000
End value           :    5000.0      5.0000      25.000      25.000
Switch. pt. up :              0.0      0.0000       0.000       0.000

output range 2
Start value         :         0.0      0.0000       0.000       0.000
End value           :         0.0      0.0000       0.000       0.000
Switch. pt. down  :           0.0      0.0000       0.000       0.000

Alarm settings  :             1           2            3           4
Measurement components :      .           .            .           .
Alarm settings  :             .           .            .           .
Acknowledge     :             0           0            0           0

Signal assignment   : Signal inputs   Relay outputs Transistor outputs
1                   :                      Failure!
2                   :                      Maintenance
3                   :                      Malfunction
4
5
6
7
8
 (! = logic: INVERS)
```

```
S 700 configuration 2 from 17.12.02 13:19:02
============================================

Program version     :  V. 1.26 from 17.12.2002
serial number       :              710790   (79211)
Device name         :               S 710

  options, software
Calib. results      :                 ON   (6443)
AK-ID active        :                OFF   (6422)
sample-hold amp.  :                    0
Semi-continuous mode :                 0
Back-flush filter   :                  0
Dilution step       :                  0
AK-ID               :                 35   (6421)
Pressure gradient   :                  0
Flow adjustment low :                  0
Flow adjustment high:                  0
Counter:            :                  0

Measured values         :              0   (6441)
Status messages  :                     1   (6442)
El. connection:                        1   (6423)
Autom. answer :                        0   (642411)
Dialing mode                           1   (642412)

Ampl.quotients sig:                    0
Step motor type  :                     5
modulator freq.   :                    7   (79244)
Modulator type    :                    1   (79245)
Press. sensor damping:               120   (79554)
Quotients value   :                    0
Measuring components    :  SO2        CO        CO2        O2    Temp. C
ADC channel       :           0         0          0         3        13
Component index :            41        30         29        40        67
Delay time        :          21        21         21         0         0

Decimal places    :           1         2          2         2         0
Bargraph disp. range:         1         1          1         1         1
no over range al. :           0         0          0         0         0
No overflow alarm.:           0         0          0         0         0
Neg. meas. val. mask:      0.00      0.00       0.00      0.00      0.00
Pos. meas. val. mask:      0.00      0.00       0.00      0.00      0.00

Concen. factor    :    5000.00      5.00      25.00      25.00    600.00
Concen. scaling:       5000.00      5.00      25.00      25.00    600.00
ADC scaling [0]:      44.6311    0.2093     1.0000     1.0000    1.0000
ADC scaling [1]:       0.3052   82.7840     1.0000     1.0000    1.0000
ADC scaling [2]:       1.0000   -0.1781    49.2124     1.0000    0.0843
Calc. ZP drift  :      1.0000    1.0000    -1.1178   482.8556    1.0000
Calc. SP drift [0]:    1.0000    1.0000     1.0000     1.0000  309.9795

Calculate ZP drift  :   -0.6480    0.0821    -0.0749    -2.7270
0.0000
Calc. SP drift [0]:    1.0085    1.0000     1.0000     1.0000    1.0000
Calc. SP drift [1]:    1.0000    0.9828     1.0000     1.0000    1.0000
Calc. SP drift [2]:    1.0000    1.0000     0.9781     1.0000    1.0000
Last ZP drift   :      1.0000    1.0000     1.0000     1.0101    1.0000
```

```
  ADC results
Date zero gas meas. 1:   03.08.02       Date zeros gas meas. 1:  02.08.02
Time zero gas meas. 1:       05:08      Time zero gas meas. 2:     20:08
  ADC results
N1                  :    -820.55    402.35    337.06    -30.45      0.76
N2                  :    -817.87    427.38    292.21     24.02      1.56
sen. zg low temp. :        14731     14731     14731     14731     14731
sen. zg high temp :            0         0         0         0         0
Temp. corr.  :      -4.31e-03  -4.02e-02  +7.21e-02  -8.76e-02  -1.29e-03

  sensitivity
Date test gas meas. 1:   03.08.02        Date test gas meas. 2:  02.08.02
Time test gas meas. 1:       05:08       Time test gas meas. 2:     20:08
  ADC results
E1                  :   10823.59   8184.06   19243.82   17818.64      0.00
E2                  :   10477.75   8196.97   19444.44   17761.46      0.00
sen. sg low temp. :        14739     14727     14747     14747         0
sen. sg high temp. :           0         0         0         0         0
Temp. corr.  :      -5.26e-05  -2.44e-06  +1.95e-05  -9.82e-06  +0.00e+00

Number of  SPT         :                5   (6251)
Man/auto SPT sel.:                      0   (6255)
Sampling points     :          1         2         3         4         5
Measuring duration per SPT :  30        30        30        30        30
Lag time per SPT    :          5         5         5         5         5
Activate SPT    :              0         0         0         0         0
```

8.12 Digital remote control (settings)

The S700 uses interface #1 (explanation and connection, see “Digital interfaces”, page 76; settings see “Digital interface parameters”, page 124) for digital communication.

Options for digital remote control:
- “Remote control with “AK protocol””, page 182.
- “Remote control with Modbus”, page 188.

8.12.1 Setting the identification character

Function

An individual identification character can be assigned to each S700 for digital remote control. The S700 will only obey commands which include its own ID character (unless this feature is disabled; see “Activating the ID character / Activating Modbus”, page 129).

Setting

1. Call-up menu 6421 (`main menu → settings → interfaces → communication #1 → AK-ID`).
   The identification character set is displayed in two ways: The character on the left and the decimal ASCII code of the character on the right (for example, `M 77`).
2. Enter the decimal ASCII code of the desired ID character (`0 … 127`).
3. Press [Enter].

! = 33	- = 45	9 = 57	E = 69	Q = 81	] = 93	i = 105	u = 117
“ = 34	. = 46	: = 58	F = 70	R = 82	^ = 94	j = 106	v = 118
# = 35	/ = 47	; = 59	G = 71	S = 83	_ = 95	k = 107	w = 119
$ = 36	0 = 48	< = 60	H = 72	T = 84	’ = 96	l = 108	x = 120
% = 37	1 = 49	= = 61	I = 73	U = 85	a = 97	m = 109	y = 121
& = 38	2 = 50	> = 62	J = 74	V = 86	b = 98	n = 110	z = 122
’ = 39	3 = 51	? = 63	K = 75	W = 87	c = 99	o = 111	{ = 123
(= 40	4 = 52	@ = 64	L = 76	X = 88	d = 100	p = 112	| = 124
) = 41	5 = 53	A = 65	M = 77	Y = 89	e = 101	q = 113	} = 125
* = 42	6 = 54	B = 66	N = 78	Z = 90	f = 102	r = 114	~ = 126
+ = 43	7 = 55	C = 67	O = 79	[= 91	g = 103	s = 115	
, = 44	8 = 56	D = 68	P = 80	\ = 92	h = 104	t = 116	

8.12.2 Activating the ID character / Activating Modbus

Function

You can determine if the S700 only reacts to remote control commands which contain its own ID character (see “Setting the identification character”, page 128), or if the S700 reacts on all remote control commands, independent of the ID character. – This menu function also serves to activate the Modbus remote control functions (see “Remote control with Modbus”, page 188).

Setting

1. Call-up menu 6422 (`main menu → settings → interfaces → communication #1 → AK-ID-active`).
2. Select the desired mode:

`without AK-ID`	ID character will be ignored – the S700 will obey all remote control commands it receives. [1]
`with AK-ID`	ID character will be observed – the S700 will only obey remote control commands with matching ID character. [1]
With AK-ID MODBUS	As `with AK-ID`, but in addition remote control with Modbus commands is enabled.

[1] Modbus functions (option) disabled, i.e. Modbus commands will be ignored.

8.12.3 Setting the installed connection

Function

This function applies for the data communication with the Modbus protocol; see “Remote control with Modbus”, page 188.

There are several options for the electrical connection – see “Creating an interface connection with a PC”, page 231. Set here which connection is installed.

> On the S700, interface #1 is used for the connection.

Setting

1. Call-up menu 6423 (`main menu → settings → interfaces → communication #1 → elect. connection`).
2. Set the installed connection:

`serial, single`	One S700 is connected directly to the PC via the interface
`serial, bus`	Several S700s are connected via BUS converters to the PC
`modem, single`	One S700 is connected via modem to the PC
`modem, bus`	Several S700s are connected via BUS converters and modems

8.12.4 Configuring the modem connection

Function

These functions are required if you have installed a digital electrical connection via modem (and intend to use it).

Settings

1. Call-up menu 64241(`main menu → settings → interfaces → communication #1 → modem → modem settings`).
2 Check/adjust the following settings:

`auto. answer`	• `auto. answer off` = the modem will not respond to incoming calls. You will need to connect the telephone line via menu command (`receive call` see “Modem control”, page 131). To do this, you must be able to notice an incoming call (for example, via the modem loudspeaker). • `after x rings` = the modem will wait for the number of rings to pass and then will automatically connect to the incoming call.
`dialing mode`	Adjust the dialing mode to the telephone system to which the modem is connected: • `tone dial` = multiple frequency dialing mode (MFV) • `impulse` = impulse dialing mode (IWF) You can also change the dialing mode when dialing a number; see “Modem control”, page 131.
`store setting`	Send a command to the modem: “Store the current settings permanently.” As a result, the modem will keep the current settings even after being shut off or after a power failure.

The modem connected to the S700 must accept standard AT commands (Hayes-compatible commands). Otherwise the S700 remote control commands will not work.

8.12.5 Modem control

Function

If you have a modem connected to interface #1, then you can remotely control its basic functions from the S700.

Actions

1. Call-up menu 6424 (`main menu → settings → interfaces → communication #1 → modem`).
2 Possible actions:

`initialization`	Restarts the modem and sends the settings for answering and dialing mode from the gas analyzer to the modem. An existing telephone connection will be disconnected, and the modem will delete all existing internal error messages. *Attention:* A remote control command just being received can then be truncated. This can produce errors in the S700.
`dialing`	Calls up a menu where you can enter a telephone number that the modem should call. – You can integrate the following special characters into the telephone number: • `.` (Decimal point) = dial pause of 3 seconds (for example, to wait for an “external line” in an internal telephone system). A “ , ” (= related Hayes command) is shown on the display. You can enter multiple dial pauses in succession, if required. • – (Minus sign) = switch to an alternative dialing mode (see “Configuring the modem connection”, page 130). The S700 will display “T” (tone dialing will follow) or “P” (impulse dialing will follow) – depending on which dialing mode was previously selected. You can switch the dial mode only once in a telephone number.
`receive call`	The modem connects to the incoming call. Select “manual answer” to use this function (see “Configuring the modem connection”, page 130) and you need to notice when a call is coming in (for example, via the modem loudspeaker).
`abort`	The modem will immediately disconnect an existing telephone connection. *Attention:* A remote control command just being received can then be truncated. This can produce errors in the S700.

If a telephone connection was established from the S700, then you need to use the `abort` function in the S700 to terminate the connection.

8.13 Data backup

8.13.1 Using an internal backup

Functions

- The data backup menu functions allow you to save a copy of S700's current working state. The data backup includes
  - all individual settings
  - all individual S700 parameters
  - the calibration at the time of the backup

  The S700 can store *two* such copies: "Last backup" and "2nd last backup". Both copies can be re-activated. As a result, it is possible to store two working conditions and restore them if required.
- In addition, S700 automatically makes a backup copy of the operating state after a successful calibration.
- You could also restore the original delivered state (factory settings). First save the current working state and then reactivate the factory settings to temporarily create "safe conditions" for testing.

- Back-up internal data on an external computer → see "Using an external backup", page 133
- Output configuration data in plain text form → see "Printing the internal configuration", page 127

Procedure

1. Call-up menu 694 (`main menu → settings → [9]` → [code] → `data storage`).
2 Select the desired function:

`store data`	Save the current working state as "last back-up" (previous "last back-up" becomes "2nd last back-up")
`last back-up`	Restore the working state of the "last back-up"
`2nd last back-up`	Restore the working state of the "2nd last back-up"
`after calibration`	Restore the working state automatically saved after the last successful calibration procedure
`factory data`	Restore the original factory-delivered state

When restoring a "backup", the latest changes of the working state are lost - unless the settings were saved beforehand → see "Using an external backup", page 133.

3 Press [Enter] to start the procedure.

8.13.2 Using an external backup

Functions

Menu `data transmission` is used to transfer the configuration of the S700 (all measuring parameters and settings) to a PC (download) and to upload it again to the S700 (upload). The data is stored in a hex-coded file with a size of some kilobytes. Application options:

- You can generate a back-up copy of all data and reload the data into the S700 if required – for example, after a major breakdown.
- When the S700 electronic board or the memory module needs to be replaced, you can reload the individual data into the new electronics.

▶ Do *not* use the `data transmission` function to copy data from one gas analyzer to another one.
These data include parameters which depend on the individual characteristics of the built-in analyzer modules. Even if analyzers are equipped with exactly the same types of modules, their internal data sets will be different. The gas analyzer will not work correctly with “foreign” data.

- Output configuration data in plain text form → see “Printing the internal configuration”, page 127
- Load firmware (internal software) → see “Firmware update”, page 136

Requirements

For the data transmission you need:

- a computer with a RS232 serial interface
- a connecting cable to interface #1 of the S700 (see “Connecting the interfaces”, page 76)
- a program which can operate the data transmission between the computer and the connected device (terminal program).

One of the programs you could use is “HyperTerminal” which is a standard part of the Windows operating system. You can start “HyperTerminal” without making a connection; this allows you to use HyperTerminal’s Help function, to become familiar with the program.

Preparations

NOTE:
Uploaded data will replace the device’s current settings.
▶ Save the device’s current settings as required:
– External see “Data backup procedure”, page 134;
– Internal see “Using an internal backup”, page 132.

1. Connect the computer with serial interface #1 of the S700; see “Digital interfaces”, page 76.
2 Start and configure the computer of the Terminal program:
▶ Set-up the same interface parameters as for the S700; see “Digital interface parameters”, page 124.
▶ Set-up the data transmission mode so that the data are transferred as a text file (ASCII data), not as binary data.

In “HyperTerminal”, the correct transfer mode is “Text file” – not “Data file”.

Data backup procedure

Use this procedure to save S700's current data:

In the S700	In the terminal program
	1 Start-up the interface connection to the S700.
2 Call-up menu 695 (`main menu → settings → [9] → [code] → data transmission`).	
3 Select `send data`.	
	4 Start data recording for ASCII data.[1]
5 Press [Enter] (this will start the data transmission).	
6 Wait until S700 indicates that the data transmission is finished (takes 40 seconds at least).	
	7 Stop data recording.[2]

[1] In "HyperTerminal": [Transfer] → [Capture text...] → select desired storage location (folder) and enter the file name under which the S700 data are to be saved as backup copy → [Start].
[2] In "HyperTerminal": [Transfer] → [Capture text...] → [Stop].

▶ To finish data recording, always use the corresponding menu command of the terminal program.
If the terminal program is just closed instead, the recorded file may become unusable (file not correctly closed).

Data restore procedure

Use this procedure to restore S700's data from a backup file:

In the S700	In the terminal program
	1 Start-up the interface connection to the S700.
2 Call-up menu 695 (`main menu → settings → [9] → [code] → data transmission`).	
3 Select `receive data`.	
4 Press [Enter] (makes S700 ready to receive data).	
	5 Send the S700 data backup file as an ASCII text file.[1]
6 Wait until S700 indicates that the data transmission is finished (takes 40 seconds at least).[2]	

[1] In "HyperTerminal": [Transfer] → [Send Text File...] → select the desired file → [Open].
[2] Display messages, see page 135

Fault displays during the data restore procedure

During `receive data` the S700 monitors the data transmission. In case of a malfunction, the S700 stops the data transmission and indicates the malfunction on the display:

Display message	Meaning	Remedy
`--OK--`	Data transmission was successful	–
`READ-TIMER`	No characters received	Check the electrical connection (plug connectors, cables).
`READ-BREAK`	Error occurred during character transmission	Set transmission delay settings in the terminal program. Proceed as follows: 1 Set a line delay; set a short delay initially. Then try the data transmission again. 2 If this does not help, increase the line delay step-by-step, up to approx. 10 ms. 3 If this does not help: Deactivate the line delay. Instead, set a character delay. Start again with the smallest value. 4 If this does not help, increase the character delay step-by-step until the data transmission works.
`READ-ERROR`		
`READ-CHAR`		

- Transmission delays will increase the time required for the data transmission.Example: A character delay of 10 ms increases the time required for the data transmission to about 3 minutes.
- On some computers, the real delay is much greater than the set value.

8.14 Firmware update

Function

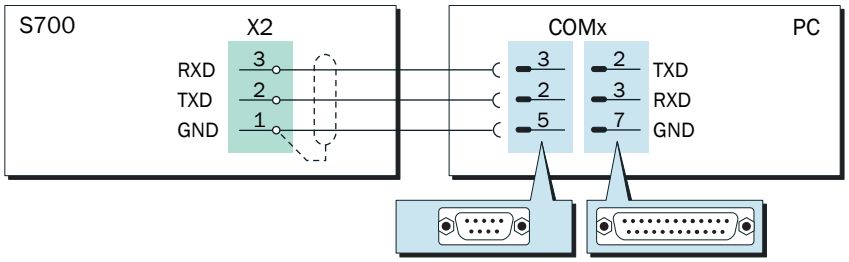
You can load the S700's internal software (firmware) from a PC into the S700 – for example, to install an new firmware version. You will need:

- a PC with an RS232 serial interface and the operating system Windows 3.X/95/98/2000/XP7/10
- a connecting cable to the S700 interface #1
- the upload program FLASH.EXE
- a current version of the file 7XX.BIN (contains the S700 firmware)

Interface connection

Three interface connections are required:

Fig. 28: Minimum interface connection for the program loader function



- Use a shielded cable.
- Cable length should not exceed approx. 2 meters (7 feet).
- You do not need to adjust the interface parameters – this will automatically be done by the upload program.

Procedure

1. Connect the PC to the S700 serial interface #1 (see Fig. 28).
2. On the PC: Store the FLASH.EXE and 7XX.BIN files in the same folder.

CAUTION: Risk for connected devices/systems
As long as the `program loader` function is activated, the S700 is not performing any measuring operation.
▶ Make sure that this situation cannot cause problems on connected devices.

3. *In S700:* Call up menu 76 (`main menu → service → program loader`) and start the function with [Enter].
   - The S700 then shows a message that it is waiting for data communication.
4. *On the PC:* Start FLASH.EXE.
   - The PC will show the messages of the upload program. The estimated remaining upload time is indicated.
   - The S700 software is divided into several "blocks". The upload program will check which blocks need to be updated and will only upload the new blocks.
   - When the upload procedure has been completed, the S700 will re-boot.
5. Wait until the S700 displays the `Man menu`. The S700 is then ready for use again.

8.15 Volume flow control

8.15.1 Setting the gas pump capacity

Function

Using this menu function, you can change the internal power supply to the built-in sample gas pump (option). This allows you to set the delivery capacity of the pump.

If the S700 has a built-in gas pump, it is recommended to use this function to set the desired gas flow rate. It is more useful than operating the pump at full power and then reducing the flow with a regulating valve. When the load on the pump is reduced, it will have a longer life.

Setting

1. Call-up menu 651 (`main menu → settings → gas flow → pump capacity`).
2 Set the `status` value so that the desired flow is attained.

8.15.2 Setting the flow monitor limit value

Function

The flow sensor (option) generates a fault signal when the sample gas flow in the sample gas path of the S700 is below the selected flow limit. This allows you to monitor the sample gas flow.

The fault indication works in two levels:

1. When the volume flow is *only slightly* below the switching point, the S700 outputs the status message `SERVICE: Gas flow` (LED “Service” and status output “Fault” are activated).
2 When the volume flow is *significantly* below the switching point (< 50 % of the set limit value), `FAULT: gas flow` is displayed (“Function” LED is red and status outputs “failure” and “service” are activated).

Setting

1. Call-up menu 652 (`main menu → settings → gas flow → flow limit value`).
2 Set the desired limit value. The setting will approximately correspond to the flow in liters per hour (the exact relation depends on each individual flow sensor).

If you need an accurate setting:
1 Connect an external flowmeter to the sample gas outlet.
2 Adjust the actual gas flow to the desired flow limit.
3 *In menu 652:* Determine the setting value by trial where the S700 outputs the `SERVICE: gas flow` message.

8.16 Displaying internal data

8.16.1 Measuring signals for the measuring components

Function

For service purposes, you can check the current measuring signals for all measuring components. These values originate from the built-in analyzer modules or, if configured, from analog inputs (see “Analog inputs”, page 69).

“ADC values” are displayed: These are the digitalized values of the analog measuring signals and serve as input signals for digital measured value processing. ADC values include analog amplification of the measuring signals, but no digital computation or correction.

The analog amplifications are variable: The optimum amplification for the measuring signals of the analyzer modules is determined during a basic calibration. For measuring signals fed-in via analog inputs, the amplification factor is manually programmed at the factory.

Typical values

- The ADC values will permanently fluctuate somewhat, even if the measured values are constant.
- When the measuring range end value is measured (which means, when the matching test gas flows through the analyzer module), “optimum” ADC values are in the range of `18000` ... `24000`. This is should be true directly after a basic calibration.

- If ADC values below `10000` are displayed for the measuring range end value, a basic calibration should be made to optimize the measured value processing again → see “Basic calibration”, page 168.
- If the ADC value remains constant for an extended period of time, then the analyzer module is possibly defective, or the electrical connection is interrupted.

Call-up

Call-up menu 7111 (`main menu → service → check values → analog signals → meas. signals`).

8.16.2 Status of the internal controllers

Function

This control function shows the actual state of the internal controllers:

- Controllers 1 to 3 are used for temperature control of the analyzer modules.
- Controller 4 does not have a function at this time (reserved for future applications).

Call-up

1. Call-up menu 7112 (`main menu → service → check values → analog signals → controller`).
2. Select the desired controller (1 ... 4).

`value`	actual measured value of the sensor
`Nominal value`	set point (factory setting)
`counter`	time delay of the temperature monitor (in seconds). When the actual temperature is outside the nominal range, the counter will advance by 1 each second. `FAULT: Temperature` is displayed when the counter exceeds the value 20. As soon as the temperature returns to nominal range, the counter begins counting backwards. After power-on, the counter starts with 128.
`cycle`	current on/off ratio for the controller, in % (minimum value = 0.0, maximum value = 99.9)
`not available`	= the controller electronics are physically not present, or the controller is not activated in the software.

8.16.3 Signals of the internal sensors and analog inputs

Function

This function displays the actual signals of the internal sensors and the analog inputs.

Call-up

▶ Call-up menu 7113 (`main menu → service → check values → analog signals → extra sensors`).

`pressure hPA`	measured value of the built-in pressure sensor (option)
`flow %`	measured value of the flow sensor (option, see “Setting the flow monitor limit value”, page 137)
`source V`	supply voltage of the infrared source of the analyzer module UNOR or MULTOR (standard nominal range: 6.0 ... 7.5 V)
`external 1 V`	Analog input signal (see “Analog inputs”, page 69)
`external 2 V`	

8.16.4 Internal supply voltages

Function

This control function shows the internal supply voltages: Nominal values are shown on the left and current actual values on the right.

If an actual value is outside the allowable range, `FAULT: int.voltage` is displayed. In such cases you may want to use this control function to locate the error source.

Call-up

▶ Call-up menu 7114 (`main menu → service → check values → analog signals → supply voltages.`).

Table 12: Internal supply voltages

Nominal value	allowable actual value
+24 V	18.0 ... 30.0 V
+24 V ext[1]	18.0 ... 30.0 V
+15 V	14.0 ... 16.0 V
–15 V	–14.0 ... –16.0 V
+12 V	9.5 ... 16.5 V
+5 V	4.5 ... 5.5 V
–5 V	–4.5 ... –5.5 V
0 V	–0.2 ... 0.2 V

[1] applies to auxiliary voltage outputs (see Fig. 22, page 72 and Fig. 23, page 72-).

Internal electronics fuses → see “Internal fuses”, page 210.

8.16.5 Internal analog signals

Function

The `overview` function displays the actual internal analog signals. These values can help a manufacturer’s service technician to diagnose the reason for a device malfunction. The signals shown depend on the individual S700 configuration.

Call-up

▶ Call-up menu 7115 (`main menu → service → check values → analog signals → overview`).

8.16.6 Bridge adjustment (THERMOR)

Function

If a THERMOR analyzer module is fitted, the S700 analyzes the individual characteristics of the module, and electronic control and signal processing are automatically adjusted to analyze the measuring component with the desired measuring range. The displayed status value (`0 ... 4095`) is a criterion for the “balance” of the electronic bridge in the THERMOR module.

Call-up

▶ Call-up menu 712 (`main menu → service → check values → bridge setting`).

8.16.7 Linearization values

Function

The linearization values represent the parameters used to compute a linear curve from the analyzer module's curve characteristic. Moreover, the linearization values include the parameters for mathematical compensation of cross-sensitivity effects.

Call-up

1. Call-up menu 713 (`main menu → service → check values → linear. values`).
2 If the S700 measures several measuring components: Select the measuring components for which you want to see the linearization values.
3 The following values will be displayed in tabular form:
   – Title: Date on which values were computed
   – Left column: Physical nominal value
   – Right column: Associated internal measured value
   When you press [Enter] or [<], related measured values for the other components will be displayed (used for internal cross-sensitivity compensation).

8.16.8 Status of the control inputs

Function

Displays the current electronic state of all control inputs; see "Control inputs", page 73.

Call-up

▶ Call-up menu 716 (`main menu → service → check values → control inputs`).

Setting	Function
0	the input is electronically passive (no current)
1	the input is electronically activated (current is flowing)
!	the input works with reverse logic

8.16.9 Program version

Function

This function displays:

– Device name of the S700 (factory setting)
– Version number and release date of the built-in software (firmware)

Call-up

▶ Call-up menu 717 (`main menu → service → check values → program version`).

8.17 Sampling point selector (option)

Only valid for devices with option “Sampling point selector”

8.17.1 Function of the sampling point selector

Sampling points are extraction points for the sample gas. With option “sampling point selector”, the S700 can control up to eight sampling points (i.e. it can give commands to switch the sample gas path):

- Display delay time (after switching-over) and sampling time can be set individually for each sampling point.
- Automatic switching can be reduced to include only some of the connected sampling points.
- Control inputs for external sampling point selection can be set-up; see “Configuration of the control inputs”, page 122.

8.17.2 Notes on the sampling point selector

... for the measured value display	• Measured values shown on the display are always the current measured values of the analyzer modules, independent from the sampling point switching. • The currently active sampling point is indicated with a number above the measured value display (see “Measuring displays”, page 97)
... for the measured value outputs	• If the S700 only measures one measuring component and two, three or four sampling points are set, then each measured value output automatically represents one of the sampling points. Each measured value output displays current measured values as long as the associated sampling point is activated. When other sampling points are active, the measured value output constantly displays the measured value that was last measured with its associated sampling point (“sample hold” function). – All settings for measured value output 1 are automatically valid for all other measured value outputs. • If the S700 measures more than one component or is set-up to sample more than four sampling points, all measured value outputs will permanently display the current measured value of the assigned measuring component. Switching outputs can be used to identify the currently active sampling point (see “Configuration of the switching outputs”, page 120). It is not possible to assign a measured value output to a certain sampling point.
... for the digital measured value outputs	• Digital measured value outputs via interface (see “Output of digital measured data”, page 125) are marked with a sampling point identification. • After switching to another sampling point, the measured value outputs are interrupted temporarily until the set “dead time” has run down (see “Configuring the sampling point selector”, page 143).

8.17.3 Configuring the sampling point selector

Function

Serves to set how many sampling points the S700 “manages” and to set-up individual times for each sampling point. To use this function practically, switching outputs have to be assigned to toggle the sample gas path to the sampling points (see “Configuration of the switching outputs”, page 120) and relevant external equipment (for example, solenoid valves) installed.

Settings

1. Call-up menu 625 (`main menu → settings → measurement → sample p. select`).
2 Make the following settings:

`No. of sample pts.`	▶ Enter the number of connected sampling points (or the number of points you currently want to use).
	• If a smaller number is set later, the remaining sampling points will be deactivated but their settings will still be held in memory. • If the S700 measures only one measuring component and less than 5 sampling points are set-up, this will effect the assignment of the measured value outputs; see “Notes on the sampling point selector”, page 142.
`Sample time per pt.`	1 Select which sampling point this setting should be applied to. 2 Enter the activation period for this sampling point during automatic sampling point selection by the S700 (0 ... 3600 s). (This determines how long the related switching output is activated see “Configuration of the switching outputs”, page 120.)
Dead time per pt.	1 Select which sampling point this setting should be applied to. 2 Enter how long the S700 should wait after activating the sampling point before it starts to send measuring data via interface #2 (0 ... 300 s). When this time has passed, the analyzer module should be completely filled with the new sample gas, and the related measured value should be at the 100 % level (criteria for this setting, see “Setting test gas delay time”, page 161).
`Activate pt.`	`yes` = the sampling point will be activated during automatic sampling point switching. [1] `no` = the sampling point will not be activated during automatic switching (however, it can still be activated via menu command or via switching output).
`man/auto pt. select`	`0` = automatic sampling point selection is activated (according to the `activate pt.` and `sample time per pt.` settings). `1` to `8` = the related sampling point is activated.

[1] Control inputs with the function “hold sample pt. x” and “ignore pt. x” have priority over the automatic sampling point selection; see “Configuration of the control inputs”, page 122.

8.18 Testing electronic outputs (hardware test)

Function

The functions in the `hardware test` menu serve to individually control and test each S700 electronic output. Furthermore, the digital interfaces can be tested. This allows you to test the electrical connections and interaction with external devices, or to test the S700 output hardware.

The hardware test function is applied to one selected output. All the other outputs will remain in operation.

CAUTION: Risks to connected devices

- When the test function is started in the menu
  - the selected output will be set to the selected electronic status
  - the operational function of this output is disabled.
- When the test is running and no key is pressed for some minutes, the selected output will automatically be reset to operating state.

▶ Make sure the test situation cannot cause problems on connected devices.
▶ During the test, consider the automatic reset. Make sure the automatic reset cannot cause problems on connected devices.

Call-up

1. Call-up menu 72 (`main menu → service → hardware test`).
2 Select the desired test function:

`measured value outputs`	1 Select the desired measured value output (OUT1 … OUT4). 2 Set the value the output should permanently display (0 `mA` = 0 % / `20 mA` = 100 %).
`relay group`	Each relay for the control and status outputs[1] can be activated individually: [2] 1 Select the desired switching output (REL1 … REL8). 2 Press [Enter] to change the relay status.[3] – `ON` = relay is activated (working state) – `OFF` = relay is deactivated (resting state)
`transistor group`	Each transistor output[1] can be activated individually: [2] 1 Select the desired transistor output (TR1 … TR8). 2 Press [Enter] to change the relay status.[3] – `ON` = output is activated (transistor is conducting) – `OFF` = output is deactivated (transistor is blocked).
`test interface #1`	As long as this function is selected, the S700 sends certain lines of characters (shown on the display). This allows you to check if data transmission to a connected device is working. [4]
`test interface #2`	

[1] See "Switching outputs", page 70.
[2] The activation will be automatically switched off after 60 seconds – unless this is done manually before.
[3] Repeat as often as required (toggle switch).
[4] If the connected printer does not print exactly the same characters as shown on the display, then the printer is probably not set to the standard ASCII character set ("US character set").

8.19 Reset

Function

A `reset` restarts the S700 microcomputer in the same way as switching the power off and on would do. The signal processing will restart. All stored values remain unchanged.

Procedure

CAUTION: Risk for connected devices/systems
During a reset, all S700 functions are shutdown temporarily. This includes measured value outputs and status signals.
▶ Make sure that this situation cannot cause problems on connected devices.

1. Call-up menu 75 (`main menu → service → reset`).
2 Press [Enter] to activate a reset.

9 Calibration

9.1 Introduction to calibration of the S700

Why is calibration necessary?

It is unavoidable that the characteristics of optical and electrical components will slightly change during the weeks of operation. These changes affect a high-precision measuring system and result in small changes of the measuring results. This effect is known as drift.

To compensate for the drift, a gas analyzer must regularly be calibrated. A calibration means that first the measuring result of the analyzer is checked, then the offset from the nominal value is adjusted to bring the analyzer back to the true reading.

The two important parameters in the measuring system are:

- The *zero point (*defined as the measuring result when the cause for a particular measuring effect is not present or should not be present).
- The *sensitivity (*defined as the relationship between the value of the measuring effect and the displayed measured value).

There is a zero point drift and a sensitivity drift for each measuring component and each must be determined and compensated.

How does a calibration procedure in the S700 work?

During a calibration, the S700 automatically compensates for drifts in the following way:

1. A test gas is fed into the S700; the true concentrations of the measuring components in test gases are known. The nominal values are the true concentrations of the measuring components in the test gas.
2. The S700 measures the concentrations of the measuring components in the test gas (measured values).
3. The S700 calculates the drifts, i.e. the differences between the measured values and the nominal values.
4. The S700 checks whether drift compensation can still be done by mathematical computation. If it is possible, the internal values for zero point and sensitivity drift compensation are automatically adjusted. If this is no longer possible, a malfunction message is displayed – which means that the measuring system should be inspected and re-adjusted by the manufacturer or trained skilled persons.

Theoretically, a complete calibration requires that this procedure is performed twice for each measuring component – once for the zero point and once for the sensitivity. Practically, in most applications, some parts of the procedure can be combined – for example, a zero point calibration for all measuring components.

Running a calibration

You can manually control the calibration procedure using the menu functions so that you can run a calibration step-by-step. Alternatively you can program the S700 so that it will run through an automatic calibration – initiated by a start command or in regular time intervals. In addition, up to four different calibration procedures can be programmed to cover different requirements; see “Setting-up an automatic calibration”, page 158.

When is it necessary to perform a calibration?

The S700 should be calibrated

- after start-up;
- during operation at regular intervals (weekly to monthly).

The calibration cuvette as substitute for test gases (UNOR, MULTOR)

The UNOR and MULTOR analyzer modules can be fitted with a “calibration cuvette”. This option allows routine calibrations of the UNOR and MULTOR sensitivity using the calibration cuvette without the need of test gases; see “Simplifying the calibration gas requirements”, page 151.

When the calibration cuvette is active, zero gas must flow through the S700; the relevant switching output is activated automatically. The nominal values of the calibration cuvette should be checked periodically; see “Calibration of the calibration cuvette (option)”, page 173.

General variations of the calibration procedure

A calibration can either run automatically or be manually controlled:

- *Automatic calibration*
  For an automatic calibration, the calibration procedure is completely controlled by the S700, including the calibration gas feed. This requires an external gas supply (for example, from gas cylinders) and automated switching devices (for example, solenoid valves) to feed the calibration gases to the gas analyzer. Before starting an automatic calibration, the nominal values for the calibration gases (see page 159), the test gas delay time (see page 161) and the calibration measuring interval (see page 162) must have been set correctly. When all this has been done, you only need to push one button in a menu or give the start signal via a control input to run an automatic calibration.
  In addition, periodical automatic starts can be programmed; see “Setting-up an automatic calibration”, page 158.
- *Manual calibration with automatic feed of test gases*
  This type of calibration requires the same external installation for calibration gas feed as an automatic calibration. However, you control the calibration procedure. This allows you to supervise each calibration step and repeat single steps if required.
- *Manual calibration with manual feed of test gases*
  In this version, you control each calibration step as in B above. However, the gas is fed “manually” here instead of being controlled by S700. External automatic devices for calibration gas feed are not required.

Please note the special information applicable for calibration of the “THERMOR 3K” special version → see “Calibrating the special version THERMOR 3K”, page 180.

9.2 Guideline for calibrations

This Section includes general recommendations for calibration gas feed and calibration procedures. Specialized measuring systems (for example, process applications with complex gas conditioning systems) may need a different, individual calibration concept.

1. *Routine calibration:* Perform normal calibrations as described in this Section in the specified maintenance periods (see “Maintenance plan”, page 198). Observe the following rules:
   – *Test gas mixtures allowed:* Test gas mixtures containing several measuring components may be used for normal calibrations.
   – *Calibrating the sample gas cooler:* If the sample gas conditioning is equipped with a sample gas cooler, feed the zero and test gas before the sample gas cooler gas feed (also applies for the zero gas for calibrations with calibration cuvette). Thus the physical influence of the cooler is identical during measurement and calibration and will be compensated.
   – *Leaving out the H2O calibration:* Do not calibrate the measuring component H_2O during routine calibrations (neither zero point nor sensitivity).
2 *Full calibration:* For analyzers with “internal cross-sensitivity compensation” (option), a full calibration should be performed in certain, long time intervals. Full calibration is also required after certain technical changes – see “Full calibration”, page 167.

9.3 Calibration gases

9.3.1 Programmable calibration gases

The S700 allows entering nominal values for 6 different calibration gases:

- 2 “zero gases” for zero point calibration of all measuring components (see “Zero gases (calibration gases for the zero point)”, page 149)
- 4 “test gases” for sensitivity calibration (see “Test gases for sensitivity calibration”, page 150).

The nominal values must be set prior to starting a calibration.

- This Manual provides a Table to record the nominal values of the calibration gases → see “User Table: Measuring components and calibration gases”, page 234.
- 4 different automatic calibration routines can be programmed combining the 6 calibration gases as desired → see “Different automatic calibration routines”, page 157.

9.3.2 Zero gases (calibration gases for the zero point)

Standard zero gas

As a rule, a zero gas should not produce a measuring effect for the measuring components zero-calibrated with this gas (nominal value “0”). Usually nitrogen can be used as the zero gas – either “technical” or “top grade” quality depending on the application.

However, you can set particular nominal values for the zero gases. This may be useful in special applications when you want to use zero gases which cause certain measuring effects. You need to know the quantitative effect and must take it into account when setting up the nominal values (usage for OXOR-P, see “Cross-sensitivity compensation with OXOR-P”, page 179).

Special zero gases

- Air: Air can be used as zero gas in some cases; see “Simplifying the calibration gas requirements”, page 151.
- *Carrier gas:* For some applications, the S700 is optimized to a certain standard sample gas composition (“carrier gas”). In this case, the zero gas should probably be a gas mixture which corresponds to the carrier gas.
- *H_2O cross-sensitivity:* Special information applies for measuring components with uncompensated H_2O cross-sensitivity, see “Calibrating H_2O cross-sensitivity measuring components”, page 179.
- *Analyzer module* UNOR *with option “flowing reference gas”:* For a S700 with this equipment, use a zero gas as span gas for calibrating the measuring components to be measured with the UNOR module; see “Display of measuring ranges”, page 100.
- *Analyzer module* THERMOR: For a zero point calibration of measuring components to be measured with a THERMOR module, use the gas or gas mixture stated on the enclosure (physical zero point) – for example, dry air, N_2, H_2, He, CO, CH_4, Ar or another gas or gas mixture.
- THERMOR and OXOR-P: The zero gas may also contain the measuring component which is measured by the THERMOR-/OXOR-P module – and this up to a concentration which corresponds to 80% of the physical measurement span. However, the nominal value for the zero and test gas must differ by at least 10% (relative to the physical measuring span).
- OXOR-P: For applications where large cross-sensitivities are present, the “interfering gas” or a gas mixture which represents the average composition of sample gas can be used as zero gas. In this way, the calibrations would physically compensate for the cross-sensitivities; see “Cross-sensitivity compensation with OXOR-P”, page 179.
- THERMOR 3K: For zero point calibration of the THERMOR 3K special version, pure CO_2 is needed; see “Calibrating the special version THERMOR 3K”, page 180.

9.3.3 Test gases for sensitivity calibration

The “test gases” are used to calibrate the sensitivity. A test gas is a mixture of zero gas and one measuring component; in many cases test gas mixtures can be used with several measuring components if required.

Appropriate nominal values

The nominal values of a test gas are the true concentrations of the measuring components in the test gas.

- *Standard nominal values:* The nominal values can be within 10 ... 120% of the physical measuring range end value – see `Min.-value` and `Max.-value` in the Setting menu; see “Setting the nominal values for the calibration gases”, page 159. For an accurate calibration, the nominal values should be within 60 ... 100 % of the physical range end value. – This does not apply for H_2O sensitivity calibration; see “Test gas feed for H_2O sensitivity calibration”, page 175.
- *Nominal value for THERMOR:* The recommended test gas for sensitivity calibration of the THERMOR module is stated on the enclosure of the S700.
- *Nominal value for THERMOR 3K*: For the sensitivity calibration of the THERMOR 3K special version, pure H_2 is needed; see “Calibrating the special version THERMOR 3K”, page 180.
- *Nominal value for OXOR-P* (measuring component O_2): If the physical measuring range end value is 25 vol.%, atmospheric fresh air can be used as test gas (nominal value for O_2: 21 vol.%).

NOTE:

- *If separate information on required test gases has been delivered:* Observe this information with priority.
- *If a test gas has been changed (for example, new test gas cylinder):* Remember to adjust the test gas nominal value in the S700.

Test gas mixtures

A test gas mixture is a mixture of zero gas and more than one measuring component. A test gas mixture can be used for simultaneous calibration of several measuring components. You could also use a test gas mixture for calibration of several gas analyzers with different measuring components.

Test gas mixtures can be used in most applications. However, please note that test gas mixtures should *not* be used in the following cases:

- If the co-existence of the gas components could physically interfere with the gas analysis
- If the gas components could chemically react with each other
- If the mixture components would produce cross-sensitivity effects in the S700 for those measuring components to be calibrated, and these cross-sensitivity effects are not automatically compensated
- If separate information was delivered with the analyzer which rules out the use of test gas mixtures.

Test gas criteria versus cross-sensitivities

- If the S700 is working with a cross-sensitivity compensation or with a carrier gas compensation, please observe the notes in Consequences of automatic compensations”, (see page 225).
- If the S700 has measuring components which have an H_2O cross-sensitivity not compensated for, please observe the notes in Calibrating H_2O cross-sensitivity measuring components”, (see page 179).

9.3.4 Simplifying the calibration gas requirements

Air as calibration gas

In some applications, it may be possible to use atmospheric fresh air for the calibration. Please note:

- If a sample gas cooler is used in the sample gas feed system and your S700 works with internal H_2O cross-sensitivity compensation (see “Cross-sensitivity and gas matrix effect compensation”, page 31), the air supplied for calibration should not be fed directly into the S700 but via the sample gas cooler inlet see “Correct feeding of the calibration gases”, page 152.
- If your S700 measures O_2 with the analyzer module OXOR-P, then air is not suitable as a zero gas, because air contains O_2. However, you could use air for the sensitivity calibration if this is within the measuring range of the analyzer.
- If your S700 measures O_2 with the analyzer module OXOR-E, then zero point calibrations are not required for the O_2 measurement; see “Analyzer modules for O_2 measurement”, page 30. In this case, air can still be used for zero point calibration of the remaining measuring components: Set the nominal values for the zero gas so that `O2` zero point calibration is disabled; see “Setting the nominal values for the calibration gases”, page 159.

Calibration cuvette (UNOR/MULTOR)

The UNOR and MULTOR analyzer modules can be equipped with a “calibration cuvette” (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 29). In this case you will only need zero gas for the routine calibration. If air can be used as zero gas, then you will only need air for your routine calibrations.

OXOR-E + UNOR/MULTOR with calibration cuvette

If your S700 is equipped with these analyzer modules and the physical range end value for the O_2 measurement is at least 21 vol.%, then air can be used as the only calibration gas for routine calibrations. Use air for the zero point calibration of UNOR and MULTOR, and also for the sensitivity calibration for the OXOR-E (O_2 measurement). Activate the calibration cuvette for the sensitivity calibration of UNOR/MULTOR.

These steps are required to prepare an automatic calibration for this method:

1. Set the nominal value for a zero gas so that O_2 is excluded from the zero point calibration (nominal value for `O2`: “ `-.-` ”; see “Setting the nominal values for the calibration gases”, page 159).
2. Use a test gas for sensitivity calibration of the O_2. Set the nominal value for this test gas as follows:
   - Nominal value for `O2: 20.9 vol.%` (O_2 concentration in atmospheric air).
   - Nominal value for all other measuring components = “ `-.-` ”.
3. Connect the switching output for this test gas with the switching output for the zero gas.
4. Exclude the other tests gases from being used for calibration; see “Setting-up an automatic calibration”, page 158.
5. In the same menu, activate the calibration cuvette (nominal values for the calibration cuvette see “Calibration of the calibration cuvette (option)”, page 173).

An automatic calibration will run as follows:

1. Air fed as `zero gas`: Zero point calibration for UNOR/MULTOR.
2. Air fed as `test gas`: Sensitivity calibration for OXOR-E.
3. `Calibration cuvette` is activated: Sensitivity calibration for UNOR/MULTOR.

9.3.5 Correct feeding of the calibration gases

Inlet pressure for devices without a built-in sample gas pump

▶ Feed the calibration gases into the analyzer at the same inlet pressure as the sample gas.

Inlet pressure for devices with a built-in sample gas pump (option)

▶ Make sure the built-in sample gas pump is switched off when calibration gases are fed into the analyzer. *Available methods:*
  – Switch the pump off manually each time; see “Switching the gas pump on/off”, page 104.
  – Activate automatic switch-off; see “Setting the nominal values for the calibration gases”, page 159.
▶ Feed the calibration gases at a slight overpressure (50 … 100 mbar).

NOTE:
Excessive pressure can damage the built-in sample gas pump.
▶ For instruments with a built-in sample gas pump, make sure the inlet pressure of calibration gases is properly limited (check the pressure regulator/reducer settings).

Gas flow

▶ Set the volumetric flow of the calibration gases identical to the volumetric flow of the sample gas (approximately).

Physical influences

The calibration gases should be fed under the same physical conditions as the sample gas. When devices are available for sample gas conditioning (for example, filter), then let the test gases flow through the sample gas conditioning before reaching the gas analyzer.

▶ As a basic principle, feed the calibration gases under the same conditions as the sample gas.
▶ *If a sample gas cooler is used:* Let all calibration gases flow through the sample gas cooler before they reach the gas analyzer (diagram, see Fig. 8, page 46).
Exception: Zero gas for calibration of measuring component H_2O (see “Calibration of measuring component H_2O”, page 174).

- Disturbing physical effects with a sample gas cooler → see “Disturbing effects with a sample gas cooler”, page 228
- Information on calibrations with a sample gas cooler → see “Calibrations with a sample gas cooler”, page 229

9.4 Manual calibration

9.4.1 Methods for calibration gas feed

Manual calibration means that you control the calibration procedure. There are two methods to deliver the calibration gases to the analyzer:

- *Manual feed:* Feed the calibration gases manually (for example, switching or opening external valves).
- *Automatic supply:* Install the external installations for calibration gas feed in the same way as for automatic calibrations (test gas cylinder and solenoid valves, which are connected to the switching outputs of the S700). When a certain calibration gas is selected in the course of the calibration procedure, it will be fed automatically to the analyzer.

Information on correct feeding of calibration gases → see “Correct feeding of the calibration gases”, page 152

9.4.2 Manual calibration procedure

Starting the procedure

▶ Select `main menu → calibration → manual procedure`.

`manual procedure`
 	
`1 zero gas 1`
`2 zero gas 2`
`3 test gas 3`
`4 test gas 4`
`5 test gas 5`
`6 test gas 6`
`7 calibr. cuvette`
`8 auto. starts`
	• When making a calibration, always start with a zero point calibration (`zero gas`).

Procedure for manual zero point calibration

`manual procedure`
 	
`1 zero gas 1`
`2 zero gas 2`
`3 test gas 3`
`4 test gas 4`
`5 test gas 5`
`6 test gas 6`
`7 calibr. cuvette`
`8 auto. starts`
	• Select the `zero gas` which has the correct nominal value programmed in the analyzer. If an automatic calibration gas feed is used, this gas must be available.

`manual procedure`
`Zero gas 2`
 	
`O2 0.00`
`CO2 0.00`
`NO 0.00`
 	
`Start zero calibration`
`Start with ENTER!`
 	
`Back : ESCAPE`
	← preset nominal values for the zero point
	← (see page 159)
	←
	
	1 If zero gas feed is not automatically controlled, feed the zero gas manually into the S700 now.
	
	2 Press [Enter] to start the internal procedure.

manual procedure Zero gas 2 Status: wait.. O2 0.27 vol.% CO2 -0.46 ppm NO 0.18 mg/m3 Please wait ... Break : ESCAPE	• After the start, the test gas delay time runs down (**wait..**; see “Setting test gas delay time”, page 161). • Then the actual values are measured (**measuring..**); at least for one period of the calibration measuring time set (see “Setting the calibration measuring interval”, page 162). – Note: The actual values displayed are drift-compensated according to the previous calibration (no “raw values”). 1 Wait until **End:** ENTER is displayed. 2 Wait until all the values are constant or remain fluctuating at a constant level. 3 Then press [Enter].
manual procedure Zero gas 2 Status: measuring.. O2 0.31 vol.% CO2 -0.44 ppm NO 0.11 mg/m3 End : ENTER Break : ESCAPE	When you press [Enter], the S700 accepts the displayed values as the true actual values and calculates the differences from the nominal values (= drifts). You can abort the calibration by pressing [Esc].
manual procedure Zero gas 2 O2 1.77 % CO2 -3.05 % NO 0.91 % Save: ENTER	← calculated values for absolute zero point drift[1] ← (for explanation, see “Display of drift values”, page 103) ← • Press [Enter] to have the S700 compensate these drifts. • Press [Esc] if you do not want to accept these values (the previous zero point calibration will be kept).

[1] = total (accumulated) drift since the last drift reset (see “Drift reset”, page 166) or the last basic calibration (see “Basic calibration”, page 168).

Procedure for manual sensitivity calibration

CAUTION: Risk of wrong calibration
- ▶ Before making a sensitivity calibration, always make the corresponding zero point calibration.
- ▶ For sensitivity calibrations of the measuring component H_2O, perform the special procedure; see “Calibration of measuring component H_2O”, page 174.

Otherwise the calibration will be incorrect.

`manual procedure`
 	
`1 zero gas 1`
`2 zero gas 2`
`3 test gas 3`
`4 test gas 4`
`5 test gas 5`
`6 test gas 6`
`7 calibr. cuvette`
`8 auto. starts`
	• Select the `test gas` which matches the nominal value set in the analyzer. If an automatic calibration gas feed is used, this gas must be available.
	• If the analyzer module to be calibrated contains a calibration cuvette, you can also select `calibr. cuvette` here.

`manual procedure`	The remaining steps are the same as with a manual zero point calibration (see page 153). Deliver test gas instead of zero gas for this procedure.[1]

[1] If “calibration cuvette” is selected, continue feeding *zero gas*; see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 29.

End of the calibration

When you have correctly calibrated the zero point and the sensitivity for all measuring components, the S700 is correctly calibrated.

To return to the measuring display:

1. Press `[Esc]` until the main menu appears.
2. Select the desired `measuring display` (see “Measuring displays”, page 97).

9.5 Automatic calibrations

9.5.1 Requirements for automatic calibrations

These are the requirements for correct automatic calibrations:

1	External devices are installed to feed the calibration gases automatically.	see “Designing the sample gas feed”, page 46
	These devices are connected to the corresponding S700 switching outputs.	see “Configuration of the switching outputs”, page 120
2	The required calibration gases are available (gas cylinders connected and sufficiently filled) and will be correctly fed.	see “Correct feeding of the calibration gases”, page 152
3	At least one automatic calibration is programmed.	see “Different automatic calibration routines”, page 157
4	The required calibration gases are correctly selected.	see “Setting-up an automatic calibration”, page 158
5	The nominal values for the calibration gases are correctly set.	see “Setting the nominal values for the calibration gases”, page 159
6	Test gas delay time and calibration measuring time are set with respect to the measuring system design.	see “Setting test gas delay time”, page 161 see “Setting the calibration measuring interval”, page 162
7	*If the S700 should start the automatic calibrations itself:* The time interval and timepoint for the first start are set as desired.	see “Setting-up an automatic calibration”, page 158
8	*If a control input is setup with the “Service lock” function:* This control input is not activated.	see “Available control functions”, page 122

Some of these settings can be checked in the `Information` menu → see “Displaying the automatic calibration settings”, page 163.

9.5.2 Different automatic calibration routines

Potential features

You can program four different automatic calibration routines where the following parameters can be set individually:

- calibration gases used
- start time for the automatic calibration
- time interval between automatic starts

All other settings for automatic calibrations (for example, drift limit values) are valid for all programmed calibrations.

Application options

- If you use an individual test gas for each automatic calibration (see “Setting the nominal values for the calibration gases”, page 159), you can set-up four independent automatic calibration routines.
- A particular measuring component can be calibrated more frequently than the others – for example, when the related analyzer module is working in a very sensitive measuring range. To do this, set-up a test gas with nominal values only for the selected measuring component (nominal values for all other measuring components = “ – ”) and configure a more frequent automatic calibration with this test gas.
- You run the fast sensitivity calibration with calibration cuvette (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 29) more frequently than calibrations with test gases. To do this, configure one of the automatic calibration routines so that only the calibration cuvette is used for the sensitivity calibration and that a shorter (more frequent) calibration interval is used.

9.5.3 Setting-up an automatic calibration

1. Call-up menu 631 (`main menu → settings → calibration → auto. calibration`).
2 Select the calibration routine: `1` ... `4` to be configured.
3 Make the following settings:

`auto cal. mode`	`zero gas 1 ... 2`, `test gas 3 ... 6` and possibly `cal. cuvette` ((see "Calibration cuvette for analyzer modules UNOR and MULTOR", page 29)) will be shown, each with the option `yes` = will be used for this automatic calibration routine `no` = will not be used • To change the status, press the related number key once. • If "`no`" is set for all calibration gases (and the calibration cuvette), then this calibration routine is practically disabled and cannot be started. During the calibration procedure, the calibration gases (and the cal. cuvette) will be activated one after another in the displayed order.
`auto cal. interval`	Time interval (days /hours) in which this automatic calibration is periodically performed. The correct setting depends on the how strong your S700 is drifting (depending on the application, analyzer modules and measuring ranges) and just how much drift from the measuring precision you can tolerate. • Standard setting: 1 ... 7 days (`01-00` ... `07-00`) • Settings for difficult applications (high measuring sensitivity) or high requirements (high measuring precision): 12 to 24 hours (`00-12` ... `01-00`). • To disable automatic starts for this automatic calibration, set 00 days/ `00` hours. • If the `auto.cal. day` was "today" and the `auto. cal. time` has already passed, then the `auto.cal. day` is automatically changed to the next day. • Also check the `auto.cal. day`, just to make sure.
`auto cal. time` `auto.cal. day`	Time and day when the next start of this automatic calibration will take place. • Subsequent start times are determined by the `auto.cal. period` (see above). • You can always change the next start time at any time by re-selecting the start timepoint. The `auto.cal. period` will start anew after this calibration. If the time input is in the past, the analyzer will show `incorrect input`. If this happens when you have entered today's date, change the `auto.cal.time` so that the start time is in the future.

If the start time for an automatic calibration occurs while another calibration procedure is running, then this second calibration will be started when the running procedure is finished.

9.5.4 Setting the nominal values for the calibration gases

Function

It is essential for correct automatic calibration that the programmed nominal values correspond to the actual concentrations of the measuring components in the calibration gases (see “Calibration gases”, page 148).

You can also select to have the built-in gas pump (option) and the switching output “external pump” (if set-up) automatically deactivated during calibration gas feed.

You must determine which of the test gases will be used during an automatic calibration (`auto.cal.mode`, see “Setting-up an automatic calibration”, page 158).

Setting

1. Call-up menu 632 (`main menu → settings → calibration → nominal values`).
2. Select a `zero gas` or `test gas`. The current settings will be displayed.

Information on menu item `cal. cuvette` (Option) → see “Calibration of the calibration cuvette (option)”, page 173.

3. Call-up `gas pump` and select if you want to have the built in pump (option) and the switching output “external pump” `on` or `off` when the calibration gases are fed into the analyzer.
4. Select one of the measuring components from the displayed list. In the following menu, enter its nominal value, i.e. the concentration of the measuring components in this test gas. *Attention:* If the test gas does not contain this measuring components, set the nominal value to “ `–.–` ” (press the backspace key) – not “ `0` ”.

CAUTION: Risk of wrong calibration

- Do not set the nominal value to “0” for measuring components not included in the test gas but to “`–.–`”.
- Do not forget to change the nominal values if a test gas has been changed (for example, when the gas cylinder has been replaced).

Otherwise the calibration will be incorrect.

When you set the nominal value to “ `–.–` ”, then the related measuring component will not be calibrated with this particular calibration gas. This setting can even be used when this measuring component is included in the calibration gas mixture.

9.5.5 Setting the drift limit values

Function

After each calibration, the S700 compares the drift limit value set against the calculated "absolute drift" of each measuring component (see "Display of drift values", page 103). The violation of a drift limit value is indicated in two steps:

1. When a drift value equals 100 ... 120 % of the drift limit value, the S700 displays the message `SERVICE: Zero drift` or `SERVICE: Span drift` (+ the measuring component involved) and activates the Service LED and the "Malfunction" status output .
2 As soon as the drift value is more than 120 % of the drift limit value, then `FAULT: Zero drift` or `FAULT: Span drift` is displayed. Status output "failure" will also be activated and the Function LED is red.

Information on the messages displayed, see "Status messages (in alphabetical order)", page 211.

Application options

Drifts are caused, for example, by contamination, mechanical changes or aging effects. It is not useful to perform more and more mathematical compensation for permanently increasing "absolute drifts". Instead, when an "absolute drift" has become very large, the related analyzer module should be inspected and readjusted (for example, cleaning procedure and a basic calibration).

Automatic monitoring can be set up for such cases by setting drift limit values for the measuring components – for example, `20 %` (maximum value: `50 %`).

Drift limit values can be used to monitor the end of the service life of the OXOR-E analyzer module → see "Replacing the O_2 sensor in the OXOR-E module", page 205.

Setting

1. Call-up menu 633 (`main menu → settings → calibration → drift limits`).
2 Make the following settings:

`Measuring component`	Measuring component selected for the following settings
`zero drift limit`	Desired drift limit value
`span drift limit`	

9.5.6 Ignoring an external calibration signal

Function

If the control inputs are setup with the function “auto. cal. start” (= start of automatic calibrations, see page 122), you can decide whether the S700 considers or ignores this input signal.

Setting

1. Call-up menu 634 (`main menu → settings → calibration → ext. cal. signals`).
2 Select the desired mode:

OFF	Input signal will be ignored
ON	Input signal can start an automatic calibration

9.5.7 Setting test gas delay time

Function

The test gas delay time determines how long the S700 must wait after switching to a calibration gas before the measured values can be used for calibration.

The delay time should correspond to the S700 response time (dead time + 100% time). To determine the response time, check for each measuring component how long it takes after switching to a calibration gas until the displayed measured value remains constant. The longest time should be used.

CAUTION: Risk of wrong calibration
Automatic calibrations will be incorrect when the test gas delay time is too short.
▶ Better select a test gas delay time which might be longer than required than one that is too short.

- On the other hand, the test gas delay time should not be longer than necessary, in order to minimize the downtime of the S700 during the calibration procedure.
- At the end of the calibration procedure, after the analyzer has switched over to measure the sample gas again, test gas delay time will run once again. This last waiting time is still a part of the calibration procedure – with all related consequences for the status messages and measured value outputs.
- The test gas delay time also applies to manual calibrations (see “Manual calibration”, page 153).

Setting

1. Call-up menu 635 (`main menu → settings → calibration → test gas delay time`).
2 Enter the test gas delay time (in seconds). – Standard value: 30 s.

9.5.8 Setting the calibration measuring interval

Function

During calibrations, the S700 starts (see “Setting test gas delay time”, page 161) the calibration measuring interval, where the measured values of the fed calibration gas are determined, after the “test gas delay time” sequence. For each measuring component, the average measured value within the calibration measuring time is calculated. These average values are used as the actual values.

The appropriate setting depends on two criteria:

- *Damping:* The calibration measuring time must be at least 150 ... 200% of the damping time constant set (see “Setting damping (rolling average value computation)”, page 111 + “Setting dynamic damping”, page 112).
- *Measuring behaviour:* The calibration measuring interval must be long enough to make sure that averaging completely compensates any existing “noise” and measured value fluctuations. The analyzer module with the “worst” behaviour is relevant.

The longer the calibration measuring time is, the more accurate the automatic calibrations will be.

The calibration measuring time also applies to manual calibrations (see “Manual calibration”, page 153).

Setting

1. Call-up menu 636 (`main menu → settings → calibration→ cal. meas. time`).
2 Enter the calibration measuring time (in seconds).

9.5.9 Displaying the automatic calibration settings

The following can be checked via menu function:

- Nominal values of the calibration gases (see “Setting the nominal values for the calibration gases”, page 159);
- Starting times of the next automatic calibrations (see “Setting-up an automatic calibration”, page 158).

1. Call-up menu 41 (`main menu → calibration → auto. calibration`).
2. Select the `auto. calibration` you want to view the settings.
3. Select `information`.

`Information`
` auto. calibration x`
`1 zero gas 1`
`2 zero gas 2`
`3 test gas 3`
`4 test gas 4`
`5 test gas 5`
`6 test gas 6`
`7 calibr. cuvette`
`8 auto. starts`
 	
` Enter digit`
	Select which parameter you want to check.

Information on zero gas, test gas or calibration cuvette (example).

`Information`
`Test gas 4`
` auto. calibration x`
`O2 21.00`
`CO2 450.00`
`NO -.--`
 	
`active yes`
`gas pump no`
 	
`Back : ESCAPE`
	← nominal value for the 1st meas. component
	← nominal value for the 2nd meas. component
	← measuring component will not be taken into account
	
	← no = will not be used for automatic calibrations
	← status of the gas pump (see “Switching the gas pump on/off”, page 104)
	
	To exit this display: Press [Esc].

Information on automatic starts of the automatic calibrations (example)

`Information`
`auto. starts`
` auto. calibration x`
`next start:`
 	
`Date : 16.09.04`
`Time : 11:30`
 	
`Period : 02-00`
`DD-HH`
 	
`Back : ESCAPE`
	
	← date and time when the next automatic
	← calibration will start
	
	← interval between automatic starts (days-hours)
	
	To exit this display: Press [Esc].

9.5.10 Starting the automatic calibration procedure manually

CAUTION: Risk of wrong calibration
For automatic calibrations, some preparations are required.
▶ Only start an automatic calibration when all requirements are fulfilled; see "Requirements for automatic calibrations", page 156.

Some important settings can be checked in the `information` menu → see "Displaying the automatic calibration settings", page 163.

▶ Select `main menu → calibration → automatic cal. → automatic cal. x → manual control`.

`manual control`
` auto. calibration x`
`Press ENTER to start`
`an automatic`
`calibration now.`
`Press ENTER.`
 	
` Continue with ENTER`
` Break : ESCAPE`
	When all requirements for an automatic calibration are fulfilled (see above): Now press [Enter].
	
	To abort the procedure, press [Esc].

`auto. calibration`
 	
`1 information`
`2 manual control`
	As long as the calibration procedure is running, `calibration running` is displayed on the status line.
	
	To abort a running calibration, select `manual control` again and confirm the abort with [Enter].

9.6 Displaying calibration data

Function

You can view the data determined and stored during the last calibration – individually for each measuring component.

Procedure

1. Select `main menu → calibration → show cal. data`.

`show cal data`
 	
`1 O2`
`2 CO2`
`3 NO`
	Select the desired measuring component.

`-Z- -S-`
`D: 31.08.04 31.08.04`
`T: 11.30.00 11.31.30`
`N: 0.00 300.00`
`R: 0.68 300.09`
 	
`Drift in %`
`abs.: 0.23 -0.20`
`dif.: 0.02 -0.03`
 	
`Back: ESCAPE`
	← zero point /sensitivity (Table heading)
	← date at the end of the last calibration
	← time at the end of the last calibration
	← nominal values from the last calibration
	← measured actual values from the last calibration
	
	← absolute drift (explanation see “Display of drift values”, page 103)
	← differences[1] in drift values to the previous calibration
	
	To exit this display: Press [Esc].

[1] = “Percentage points” ($Dif_X = abs_X - abs_{X-1}$).

No calibration data are displayed when no calibration has been performed after the last drift reset (see “Drift reset”, page 166) or last basic calibration (see “Basic calibration”, page 168). (This is also true for brand-new analyzers.)

A calculated drift difference represents the relation between test value and nominal value. For the *sensitivity drift,* the drift difference is always computed with reference to the *larger* value of the two values.

- *Example 1:* The test gas nominal value is 100 ppm.
  The test value during calibration was 98 ppm.
  Sensitivity drift = (98-100)/100 = -2.00 %
- *Example 2* The test gas nominal value is 100 ppm.
  The test value during calibration was 102 ppm.
  Sensitivity drift = (102-100)/102 = + 1.96 %

With this method, positive and negative physical drifts are calculated with a different mathematical loading. *Effect:* When a physical drift occurred and then changed back by the same amount, the calculated absolute drift is also back to the original value. Without the different mathematical loading, the absolute drift would differ from its previous value and thus no longer represent the actual physical state of the measuring system.

Drift values can be monitored automatically → see “Setting the drift limit values”, page 160. *Effect:* An error message is displayed when, after a calibration, a drift value is greater than the relevant drift limit value.

9.7 Drift reset

Function

When a drift reset is made, the S700 cross-calculates the current “absolute drifts” (see “Display of drift values”, page 103) then starts totaling “absolute drifts” again at “0.0”. The drift reset also serves to start recording “absolute drifts” at any time – for example, to check the analyzer’s drift over a certain period of time.

CAUTION: Risk of wrong calibration

If very high drift values are displayed after a manual calibration, then probably the test gases did not correspond to the programmed nominal values, or the test gas feed was faulty. And – although great discrepancies had been displayed – the calibration had been accepted by keypad entry.

- ▶ Never try to correct such a faulty situation by making a drift reset. Instead, try to calibrate the analyzer again carefully.

NOTE:

- A drift reset cannot be undone.
- A drift reset will discard the “history” of the “absolute drifts”.

NOTE:

- ▶ Do not use the drift reset to compensate for strong physical changes of an analyzer module – first make the required mechanical or optical adjustments.[1]
- ▶ Make a drift reset whenever an analyzer module has been cleaned or replaced.

[1] Such work should be carried out by a trained service technician.

Procedure

1. Call-up menu 73 (`main menu → service → drift reset`).
2. Enter the `Code:` [7] [2] [7] [5] [Enter]
3. Wait until `End: Enter` is displayed.
4. Press [Enter] to finish the procedure.

9.8 Special calibrations

9.8.1 Full calibration

Only applies for analyzers with the "internal cross-sensitivity compensation" option.

When to perform a full calibration

For analyzers with "internal cross-sensitivity compensation" (option), perform a full calibration procedure in the following time intervals:

- *For measuring components SO_2, NO, H_2O:* Regularly once a year
- *For other measuring components:* Regularly every two years

A full calibration should also be made if one of the following modifications has been made:

– Adjustment, modification, or replacement of an analyzer module
– Firmware update to software version 1.26 or 1.27

How to perform a full calibration

Perform the following two calibration procedures in succession –

1. A basic calibration (see page 168) for each of the S700 measuring components
2 A calibration of cross-sensitivity compensations (see page 177).

– following these rules during these calibration procedures:

- *Using pure test gases:* Use an individual "pure" test gas (mixture of zero gas and the relevant measuring components). Do not use test gas mixtures.
- *Feed dry test gases:* Directly feed the calibration gases into the gas analyzer, not through a sample gas cooler (when fitted).
- *H_2O calibration:* When the S700 is equipped with an analyzer module type MULTOR, which measures SO_2 as well as NO, also perform the calibration procedures for the measuring component H_2O.

9.8.2 Basic calibration

Need for a basic calibration

In the course of a basic calibration, both the analog and digital signal processing are measured and optimized anew. A basic calibration should be performed in the following situations:

- *After exchanging, readjusting or modifying an analyzer module:* The analog amplification of the relevant measuring component must be optimized again because these actions usually change the physical characteristic of the analyzer module.
- *When the digital drift compensation has reached its limit:* The digital part of the measured value processing can be optimized again at any time with a drift reset; see “Drift reset”, page 166. However, the analog drift causes remain and must still be compensated. When the mathematical compensation is very large, then it might occur that the specified measuring precision is no longer maintained. This problem can be solved by performing a basic calibration, because this includes reoptimization of the analog sections.

Principle procedure for a basic calibration

During a basic calibration, the following happens in principle:

1. The measuring signals of the analyzer module are checked, and the electronic amplification of the measuring signals is reoptimized to match.
2 The basic parameters of the mathematical measured value processing are recalculated (in the same way as during a drift reset, see page 166).

This happens individually for each measuring component and requires matching calibration gases. For a complete basic calibration, the procedure must be completed for each measuring component individually. You can run the procedure for certain measuring components only, for example, when the basic calibration is only required for a particular analyzer module.

Requirements for a basic calibration

To perform a basic calibration, you need the following:

- *Time:* Depending on the number, type and measuring range of the measuring components, the procedure can take approx. 20 to 120 minutes. During this time, the normal measuring function is deactivated.
- *Manual gas feed:* The calibration gases have to be fed manually into the S700 (for example, via a hose connection or a manual valve).
- *Knowledge of the physical zero points:* Check the “span gas” information, see “Display of measuring ranges”, page 100 for each measuring component for which a basic calibration is to be performed. Because either the zero gas or the test gas must correspond to this value during a basic calibration; (see Table)13.
- *Calibration gases:* For a basic calibration, an appropriate zero gas and test gas are required for each measuring component:

Table 13: Appropriate calibration gases for a basic calibration

“Span gas” value is	Nominal value for `zero gas`	Nominal value for `test gas`
Close or identical to the start value of the physical measuring range (standard).	identical to the “span gas” value	End value of the physical measuring range [1]
Close or identical to the end value of the physical measuring range (special case).	Start value of the physical measuring range [1]	Identical to the “span gas” value

[1] ± 20 % of the measurement span. The `min/max` values are set accordingly.

- When calibrating the measuring system of the S700 “from scratch”, it may be useful to clean and/or readjust the analyzer modules before the basic calibration is performed.
- Modifications to the analyzer modules should only be made by trained service technicians or trained and authorized skilled persons. Otherwise the manufacturer’s product guarantee will no longer be valid.

Special information applies for the special version THERMOR 3K; see “Calibrating the special version THERMOR 3K”, page 180

Starting a basic calibration

CAUTION: Risk for connected devices/systems

During a basic calibration, the measured value outputs will work in the following way:

- Measured value output OUT1 outputs the internal measuring signals measured during the procedure (“ADC values”).
- Measured value outputs OUT2, OUT3 and OUT4 constantly show the last measured value measured before the basic calibration procedure began.

▶ Make sure that this situation cannot cause problems on connected devices.

NOTE:

If a basic calibration could not be completed successfully, then the S700 measuring function is no longer guaranteed.

▶ If you have any doubts during the basic calibration process, cancel the procedure by pressing [Esc]. This will retain the previous state.

▶ *Recommendation:* Backup the current data of the S700 before starting a basic calibration; see “Using an internal backup”, page 132. This will allow you to repair the S700 if the basic calibration fails.

When a basic calibration is started, the S700 should already be in operation at least one hour, to ensure all internal temperatures are stable.

Special information applies for the special version THERMOR 3K; see “Calibrating the special version THERMOR 3K”, page 180

Call-up menu 74 (`main menu → service → basic calibration`).

Procedure for a single measuring component

1. Call-up `meas. component`.
2 Select the measuring component for which the following procedure will be carried out.
3 Call-up `zero gas`.
4 Enter the nominal value of the zero gas (see “13”, page 169).
5 Call-up `test gas`.
6 Enter the test gas nominal value (see “13”, page 169).
7 When the nominal values have been correctly entered, select `measure`.
8 *Only for measuring components measured with the THERMOR analyzer module*: The following is now displayed (example):

`H2`
 	
`Deliver the physical`
`zero gas and wait`
`until the signal`
`is stable.`
 	
`Actual value  0.234`
 	
`Continue with ENTER`
	← THERMOR measuring component

a) Feed the calibration gas which corresponds to the “span gas” for this measuring component.
b) Wait until the `Actual value` is nearly constant (`±0.1`).
c) Press [Enter].
The S700 now performs an electronic adjustment of the THERMOR module (bridge adjustment); here, the `Actual value` is minimized. `Please wait` is displayed during the process (approx. 2 minutes).
d) Wait until `Continue with ENTER` is shown again. Press [Enter] to accept the adjustment.

9 A display message signals that the procedure is continued with the calibration gas which creates a higher measuring signal (usually the `test gas`). Press [Enter] to continue. The following is displayed (example):

`CO2  30.000 vol.%`
 	
`Enter CO2 test gas`
 	
`30.000 vol.-%`
 	
`0.000 vol.%`
 	
`Continue with ENTER`
`0 = fixed amplific.`
	← measuring component and nominal value of the calibration gas
	
	← only after sufficient waiting time as elapsed
	← *only for trained personnel* [1]

[1] Press [0] = current analog amplification will be retained (will not be corrected). This can save time when the procedure had already been run completely and is now repeated after a short time. Not recommended for a completely new basic calibration.

10 Feed the displayed gas (*Attention:* The procedure starts with the *larger* nominal value.)
11 Wait until the gas has completely filled the internal gas path, replacing the previous gas (appropriate purge time).
12 Press [Enter].

In the following step, the S700 optimizes the analog amplification of the measuring signal for the selected measuring component. The display will show (for example):

CO2 30.000 vol.%	← measuring component and nominal value of the calibration gas
CH4	
CO2 18559 341	← other measuring component ← ADC value[1]; analog amplification stage[2] [3]
CO	← other measuring component
18.3%	
Please wait ...	← progress of the internal procedure

[1] current digitized measuring signal (–32768 ... 32768)
[2] will automatically change and be adjusted during the procedure (0 ... 4095)
[3] values will only be shown for the selected measuring component

13 Wait until the display changes from `please wait ...` to the following:

When values are stable, start with Enter.	

14 Wait until the ADC value is “stable”, i.e. until it fluctuates around a constant average value (±50). Then press [Enter].

The ADC values displayed in this step (automatic amplification optimization) and in the next step (calibration measurement) may be different.

After this step, the S700 runs a calibration measurement with test gas (procedure takes 30 times longer than a normal measurement does). The completion of the procedure will be shown in %.

15 Wait until `Save: ENTER` is displayed. Press [Enter] to accept the displayed value. The following is displayed (example):

Enter CO2 zero gas 0.000 vol.% Continue with ENTER	

16 Feed the calibration gas shown. Press [Enter].
The following is displayed (example):

CO2 0.000 vol.%	
CH4	
CO2 1742	← ADC value [1]
CO	
When values are stable, start with Enter.	

[1] may rapidly change until the new gas has completely purged out the old gas

17 Wait until the ADC value is “stable”, i.e. until it fluctuates around a constant average value (±50). Then press [Enter].
The S700 then runs a calibration measurement with zero gas. The progress of the procedure will be shown in %.

18 Wait until `Save: ENTER` is displayed. Press [Enter] to accept the displayed value.

The S700 now calculates the “linearization values” (calibration curve). The variables of a basic mathematical function are modified until the optimum calibration function is found. The progress (%) and the number of iteration steps are displayed.

19 Wait until a display like this is shown:

`CO2 1.234`
 	
`Save: ENTER`
	← Measuring component; variation coefficient[1]

[1] represents the offset of the measured calibration values from the new calibration function. Values under `5.000` are typical; for difficult applications, the values can be larger.

20 Wait until `Save: ENTER` is displayed.

If the procedure was not successful, a malfunction message is displayed: under the word `FEHLER` (all menu languages), the calibration gas and the measuring component which could not be processed are displayed.

- ▶ *Clearance:* Terminate the procedure and repeat it carefully (check nominal values, feed calibration gases correctly, observe purge times).
- ▶ *If this does not help:* Contact the manufacturer's Customer Service for advice. Or restore the previous S700 values to use the analyzer in its previous state (can only be done when a data backup was made before starting the basic calibration; see “Using an internal backup”, page 132.

21 Press [Enter] to accept the displayed values for the basic calibration of the selected measuring component.

Repeat for the other measuring components

The following steps will be necessary,

- when the S700 measures several measuring components and a *complete* basic calibration should be made;
- when the basic calibration is made for an analyzer module which measures *several* measuring components (MULTOR).

22 `In the basic calibration` menu, select another measuring component and repeat the procedure for this new component, as described in “Procedure for a single measuring component”, page 170.

23 Repeat this until the „Procedure for a single measuring component“ has been made for all desired measuring components.

- When the `basic calibration` function terminates, a test gas delay time (see “Setting test gas delay time”, page 161) will run down before the measured value outputs displays the current measured values again.
- If you have *terminated* a running basic calibration at any step of the procedure (using the [Esc] key), then the previous state of the basic calibration is kept.

Calibration with new cross-sensitivity calculation

24 *Only for devices which work with “internal cross-sensitivity compensation” (option):* Perform a new, full calibration of the cross-sensitivity compensation after a basic calibration; see “Calibration of cross-sensitivity compensations (option)”, page 177.

9.8.3 Calibration of the calibration cuvette (option)

This information only applies for S700 with the option “calibration cuvette” (explanation see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 29).

Function

The calibration cuvette simulates the presence of a test gas – thus there are nominal values for the calibration cuvette, as there are for test gases. Each calibration cuvette has individual nominal values; these nominal values are first determined at the factory and saved in the S700.

We recommend to check these values approximately every 6 months, and correct if required. Practically this results in a calibration of the calibration cuvette. Because the S700 itself is used as the reference system, it must be “basic-calibrated” beforehand, using “real” test gases.

Procedure

1. Perform *one* of the following procedures:
   - Perform a calibration with test gases (not with the calibration cuvette). Zero point and sensitivity of the analyzer module UNOR and/or MULTOR must have been calibrated with test gases afterwards.
   - Perform a basic calibration → see page 168.

- If your S700 is equipped with several analyzer modules, you can set-up this procedure to include only the measuring components measured with UNOR and/or MULTOR.
- For the analyzer module MULTOR, you can also run the procedure for an individual measuring component.

NOTE: Erroneous calibrations possible

▶ Proceed with the following steps only if one of the procedures in step 1 has successfully been performed just before.

Otherwise accumulated drift values could influence the nominal values of the calibration cuvette.This state could remain unnoticed and can only be eliminated by performing a basic calibration.

2 Feed zero gas into the S700.
3 Call-up menu 6327 (`main menu → settings → calibration → cal. cuvette`).
4 Select `check`.
As long as `check` is selected, the calibration cuvette is moved into the optical beam of the analyzer module, and current test values for the UNOR/MULTOR measuring components are displayed. The bar graph display will show the internal modulation range.
5 Wait until all the check values are constant.
6 Note down the displayed check value for each UNOR/MULTOR measuring component.
7 Press [Esc] to return to menu 6327.
8 Call-up the displayed measuring components one after another and, in the following menu, enter the noted check value as the new `status` value.

9.8.4 Calibration of measuring component H_2O

This information only applies for the S700 with measuring component H_2O (also see "Measuring component H_2O", page 226).

Special characteristics of the H_2O calibration

- The zero gas must be "dry". If a sample gas cooler is used, the zero gas must not flow through the sample gas cooler.
- The required test gas is not available from gas cylinders, it must be produced "locally".
- The requirements for accuracy are much less stringent when the H_2O measured value is only used for internal cross-sensitivity compensation (see "Cross-sensitivity and gas matrix effect compensation", page 31) – see the following notes.

Easier calibrations for H_2O cross-sensitivity compensation

If the H_2O measured value is only used for internal cross-sensitivity compensation, then the H2O measurement can work at a lower precision level than the other measuring components. This makes H_2O calibrations easier in the following way:

- You can select much longer calibration intervals for H_2O than for the other routine calibrations. Recommended interval: 1 year.
- The zero gas must not be absolutely "dry". Small residual H_2O concentrations are allowed (500 ppm H_2O).
- The nominal value set for the H_2O test gases does not have to exactly meet the real physical value - it suffices when the nominal value is set to a "roughly" correct value. The important criterion is that the physical conditions in the gas supply system should be identical during both measuring operation and calibration and are kept constant during operation; this applies especially to sample gas coolers.

Zero gas for H_2O calibrations

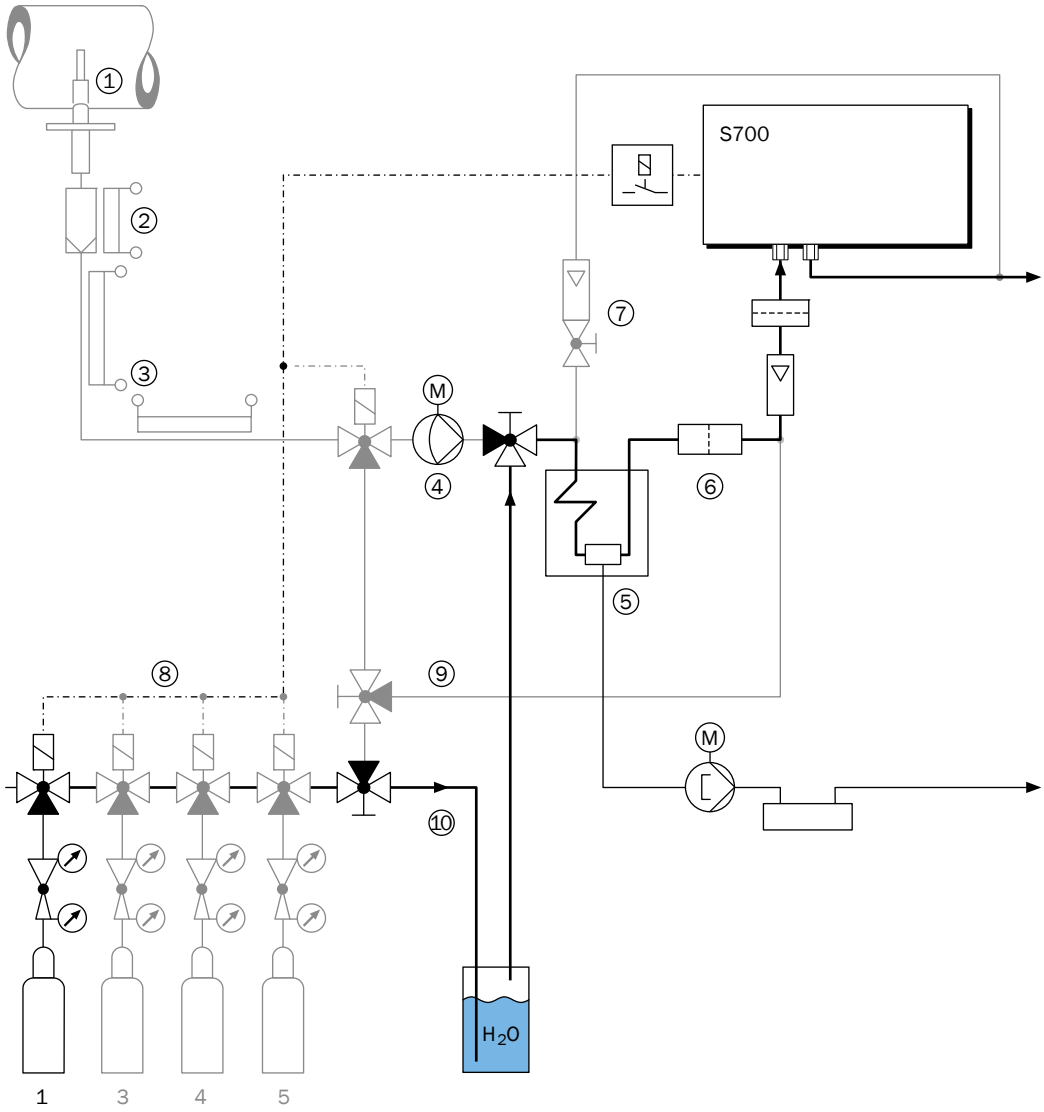
The zero gas for H_2O calibration may not contain any H_2O – which means it must be "dry". To meet this requirement, the zero gas should be supplied from the gas cylinder *directly* into the analyzer and must *not* flow through a sample gas cooler. You may want to use a bypass line, if available (installation notes, see "Designing the sample gas feed", page 46). If atmospheric air is used as the zero gas, the air must be dehumidified before being fed into the analyzer (methods, see "Calibration of cross-sensitivity compensations (option)", page 177).

Test gas for H_2O calibrations

Create the test gas for a H_2O sensitivity calibration as follows (see Fig. 29, page 175):

1. Let nitrogen (zero gas) flow through water – for example, through a wash bottle or a vessel with water-saturated cotton wool. Water temperature: 15 ... 30 °C (room temperature).
2 Let the vapor-saturated gas flow through a sample gas cooler (cooler temperature: 2 ... 6 °C). After the gas has run through the cooler, the H_2O concentration in the gas corresponds to the vapor pressure at the cooler temperature (see "15", page 176). – Feed this gas during the H_2O sensitivity calibration.

Fig. 29: Test gas feed for H_2O sensitivity calibration



Nominal values of the H_2O calibration gases

Program the following nominal values for one zero gas and one test gas each for the H_2O sensitivity calibration (see “Setting the nominal values for the calibration gases”, page 159):

Table 14: Nominal values for H_2O calibration

	nominal value ...	
	... for `H2O`	... for all other measuring components
... for zero gas	`0.00`	“`-.-`” (= will not be calibrated)
... for test gas	(see Table)15	or a matching nominal value (if required)

Table 15: Nominal values for H_2O test gas

Cooler temperature	2 °C	3 °C	4 °C	5 °C	6 °C	7 °C	8 °C	9 °C
H_2O nom. value [ppm]	6960	7470	8010	8590	9210	9870	10580	11320

The H_2O measurement has been calibrated at the factory. This fact can be used: As long as your S700 is brand-new, the nominal value of H_2O test gas can be determined by having it *measured* once by the S700. You can use the measured H_2O value as the nominal value as long as there is no change in the sample gas cooler.

Procedure for an H_2O calibration

1. Feed “dry” zero gas into the S700, as described above.
2. Perform a manual zero point calibration; see “Manual calibration procedure”, page 153.; use the prepared `zero gas`.
3. Deliver the test gas for H_2O sensitivity calibration to the S700, as explained above.
4. Perform a manual sensitivity calibration using the prepared `test gas`.

9.8.5 Calibration of cross-sensitivity compensations (option)

This information is only valid for S700 analyzers with the option “internal cross-sensitivity compensation”; see “Cross-sensitivity and gas matrix effect compensation”, page 31.

Function

While usual calibrations will calibrate the zero point and sensitivity of a measuring component, it is possible to make special calibrations which include the re-calibration of the internal cross-sensitivity compensations. During such calibrations, the S700 will additionally check for cross-effects which occur in the analysis of all those measuring components associated for cross-sensitivity compensation, and then will re-adjust the compensations accordingly. The corresponding menu function is “Calibration with correction”.

Calibrations “with correction” may be more demanding than normal calibrations (because of more exacting requirements for the calibration gases), but they only need to be done at long time intervals. Recommended calibration periods are:

- *For measuring components SO_2, NO, H_2O:* 1 year
- *For other measuring components:* 2 years

Calibration gases requirements

- Pure test gases should be used for “calibrations with correction” which means each test gas consists of the zero gas and one measuring component. You may also use test gas mixtures which include more than one measuring component if it is sure that the mixed components do not produce any interfering effects.
- For devices with calibration cuvette (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 29), it is required to use test gases instead of the calibration cuvette for this calibration.
- For devices with internal cross-sensitivity compensation, all calibration gases must be “dry”, i.e. they must not contain any measurable H_2O concentration (*-exception:* test gas for H_2O sensitivity calibration, see “Calibration of measuring component H_2O”, page 174). To meet this requirement, the calibration gases should be fed from the gas cylinders *directly* into the analyzer and must *not* flow through a sample gas cooler. You may want to use a bypass line, if available (installation notes, see “Designing the sample gas feed”, page 46). – If atmospheric air is used as the zero gas, the air must be dehumidified before being fed into the analyzer.

Following methods for gas dehumidification are:
- Let the calibration gases flow through a low-temperature gas cooler.
- Let the calibration gases flow through a dehumidifying agent, for example, SilicaGel. Please note that the agent should not affect the other gas components.

Procedure

1. Call-up menu 696 (`main menu → settings → [9] → [code] → cal. w/ correction`).

> In analyzers equipped with software version 1.26 (or previous), this function is located in menu 637 (`main menu → settings → calibration → cal. w/ correction`).

2 Set the function status to `ON`.
3 Perform a calibration procedure as usual, however:
   – Use “pure” test gases or “cross-effect free” test gas mixtures.
   – For analyzer modules UNOR/MULTOR with calibration cuvette (option), do not use the calibration cuvette in this calibration procedure; use test gases instead.
   – With internal H_2O cross-sensitivity compensation: Use H_2O-free (“dry”) calibration gases and do not feed the calibration gases through a sample gas cooler during this calibration (except for H_2O sensitivity calibration; see “Calibration of measuring component H_2O”, page 174).
4 When the calibration procedure has finished, set the “calibration with correction” function status to `OFF`.

> ▶ Make sure that during measuring operation and routine calibrations, the `cal. w/ correction` function is set to `OFF`.

9.8.6 Calibrating H_2O cross-sensitivity measuring components

If all of the following criteria apply to your S700:

- the sample gas contains H_2O
- an internal H_2O cross-sensitivity compensation is not active
- at least one measuring component (for example: SO_2, NO) has a cross-sensitivity against H_2O and this interfering effect is large enough to affect the specified measuring precision
- a sample gas cooler is used

you must ensure that the calibration gases contain the same H_2O concentration as the sample gas when they reach the gas analyzer during calibration (of the “cross-sensitive” measuring components).

You can achieve this as follows:

1. First, produce a high H_2O gas concentration in the calibration gases. To do this, install a suitable vessel in the calibration gas path, filled with water, and make the calibration gases bubble through the vessel.
2 Feed the calibration gases from the water vessel through the sample gas cooler into the gas analyzer. The sample gas cooler will reduce the H_2O concentration to the same level as in the sample gas.

9.8.7 Cross-sensitivity compensation with OXOR-P

Only valid for S700 with “OXOR-P” analyzer module *(see “Analyzer modules for O_2 measurement”, page 30)**.*

Physical interference effect

If the zero point of the OXOR-P module is calibrated with nitrogen and the sample gas consists mainly of other gases with considerable paramagnetic or diamagnetic susceptibility, then major measurement errors might occur. In this case, the S700 could display a measured value for O_2 even when the sample gas does not contain any oxygen.

Compensation methods

There are three methods to compensate for this interference effect:

- *Adapted zero gas:* Use the corresponding “interfering gas” or an O_2-free gas mixture representing the average sample gas composition as zero gas. Because the zero point is calibrated more or less under measuring conditions, the cross-sensitivity effect is “calibrated in”.
- *Manual compensation:* Use normal zero gas to calibrate the zero point and do not set the setpoint value for zero gas to “0” but to a value that exactly counters the cross-sensitivity effect. In this way, the zero point is constantly shifted, which compensates for the cross-sensitivity effect.
- *Automatic compensation:* The S700 measures the interfering gas component(s) simultaneously with own analyzer modules and compensates the cross-sensitivity effects with the help of these measured values (“internal cross-sensitivity compensation” see “Cross-sensitivity and gas matrix effect compensation”, page 31).

9.8.8 Calibrating the special version THERMOR 3K

Only applies for S700 with THERMOR 3K analyzer module *(see "Special version "THERMOR 3K"", page 222)**.*

Calibration restrictions

- It is always required to calibrate both the zero point and the sensitivity (see "Introduction to calibration of the S700", page 146).
- Nominal values for calibration gases (see "Setting the nominal values for the calibration gases", page 159) are fixed as follows and cannot be changed:

Zero gas	(for zero point calibration)	100 vol.% CO2	(pure CO_2)
Test gas	(for sensitivity calibration)	100 vol.% H2	(pure H_2)

Safe calibration procedure

WARNING: Risk of explosion caused by hydrogen (H_2)
Gas mixtures of hydrogen + oxygen or hydrogen + air are highly explosive.
- ▶ Do not mix hydrogen and oxygen.
- ▶ Do not mix hydrogen and air.
- ▶ Never feed hydrogen into a gas path filled with oxygen or air.
- ▶ Never feed oxygen or air into a gas path filled with hydrogen.
- ▶ Make sure that gas paths used alternatively for hydrogen and oxygen/air are purged with a "neutral" gas (for example, N_2 or CO_2) before the other gas is fed.

Maintain the following sequence for safe feeding of the calibration gases:

1. *Before the calibration:* Feed the test gas "pure CO_2" into the sample gas path of the S700 (to remove air from the gas path).
2. Let the zero point calibration run with this gas.
3. Feed "pure H_2" as the test gas.
4. Let the sensitivity calibration run with this gas.
5. *After the sensitivity calibration:* Feed CO_2 again until H_2 is completely discharged.

Basic calibration with the special version

- Three calibration gases are required for a basic calibration (see page 168):

Physical zero gas	air (fresh atmospheric air)	
Zero gas	100 vol.% CO2	(pure CO_2)
Test gas	100 vol.% H2	(pure H_2)

- In the basic calibration procedure, the measuring component selection is not required. The basic calibration will automatically be made only for the measuring component H2–CO2. The S700 automatically calculates the values for the other measuring components.

9.9 Validation for UNOR/MULTOR

Only applies for S700 with analyzer module UNOR or MULTOR with calibration cuvette (see "Calibration cuvette for analyzer modules UNOR and MULTOR", page 29).

Function

If the S700 is equipped with an UNOR or MULTOR analyzer module and a calibration cuvette, you can use the `Validation` function to quickly check whether the measuring system is functioning correctly. During a validation, the S700 simulates a calibration procedure with test gases, but, however, uses the calibration cuvette instead of test gases. At the end of the procedure, real measured values are displayed which should be compared with the nominal values (previously displayed); if the values are similar, the UNOR/MULTOR module is functioning correctly.

The procedure requires feeding zero gas.

A validation does not change the calibration.

Procedure

1. Call-up menu 44 (`main menu → calibration → validation`).
2. Feed in zero gas (see "Zero gases (calibration gases for the zero point)", page 149). The switching output zero gas path 1 is automatically activated; when the zero gas feed is controlled via this switching output, the zero gas automatically flows in.
   The nominal values of the calibration cuvette are displayed (example):

`calibration 44`
`Validation`
 	
`CO 1598.9 ppm`
`NO 3997.1 ppm`
 	
`Validation`
`Start with ENTER!`
	← Nominal values
	←
	
	Please note down these values or keep them in mind.

3. Press [Enter] to start the automatic validation procedure. – The display will show the measured values of all measuring components (example):

`Status: Measuring`
 	
`CO 1540.2 ppm`
`NO 3409.4 ppm`
`SO2 702.5 ppm`
`H2O 26.5 ppm`
 	
`Please wait ...`
	
	← actual values
	←
	←
	←

4. Wait until `Back: ESCAPE` is displayed.
5. Compare the actual values with the nominal values. If the values are similar, then the UNOR/MULTOR analyzer module is working correctly.
6. Press [Esc] to leave the procedure.

10 Remote control with “AK protocol”

Only applies for S700 with option “limited AK protocol”.

10.1 Introduction to remote control with “AK protocol”

The “AK protocol” is a software specification for digital interfaces defined by the German automobile industry. The S700 “limited AK protocol” option provides some remote control functions related to this specification.

Using the “limited AK protocol” remote control commands, you can

- activate and deactivate the “limited AK protocol” remote control mode
- call-up the current device status of the S700
- remotely control and set some of the calibration functions

10.2 Technical basics

10.2.1 Interface

Interface #1 is used for the remote control (pin assignment, see “Plug connector X2 (interfaces)”, page 76). The standard interface parameters are:

Baud rate	9600
Data bits	8
Parity	None
Stop bits	1

Setting, see “Digital interface parameters”, page 124

10.2.2 Complete command sequence (command syntax)

A complete remote control command consists of the following characters:

- First character = character STX (02hex).
- Second character = ID character [AK-ID] of the S700 (see “Setting the identification character”, page 128).
- The [AK-ID] is followed by the 4-character command plus additional parameters (if required). There must be a space character (20hex) between the command and each parameter.
- Last character = character ETX (03hex).

Byte	Contents
1	character STX (02hex)
2	[AK-ID]
3 ... 6	four command characters
7 ... (n-1)	space character + parameter, if required
n	character ETX

10.3 Command types

There are 3 types of remote control commands:

First command character	General function	Available
A	Read data from the S700	Always (no preparation required)
E	Change settings in the S700	When remote control is activated (see “General commands”, page 185)
S	Start S700 procedure	

10.4 Reply to a received command

The S700 checks every command it receives and sends a “reply”.

10.4.1 Status character

Part of the reply is a status character which gives information about the internal status of the S700:

- Normally the status character is 0.
- The status will increase by 1 for any of the internal faults:
  `FAULT: gas flow`
  `FAULT: chopper`
  `FAULT: step motor`
  `FAULT: temperature`

Other status or malfunction messages do not influence the status character. Use the AFLT remote control to obtain complete status information (see “Status reading commands”, page 185).

10.4.2 Normal reply

Command status	Reply	
The received command will be executed.	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	[received command]
	Byte 7	[space character]
	Byte 8	[status character] [1]
	Byte 9 ... n	[space]+[parameter]
	Byte n+1	ETX

[1] see “Status character”, page 183.

10.4.3 Reply to an erroneous command

Command status	Reply	
The [AK-ID] character in the received command does not match the ID character of this S700 (see “Setting the identification character”, page 128).	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	????
	Byte 7	[space character]
	Byte 8	[status character] [1]
	Byte 9 ... n	[space]+[parameter]
	Byte n+1	ETX
The received command began with E or S, but the remote control is not activated (see “General commands”, page 185).	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	[received command]
	Byte 7	[space character]
	Byte 8	[status character]
	Byte 9	[space character]
	Byte 10 ... 13	SMAN
	Byte 14	ETX
The received command cannot be executed at this time. (Example: While an automatic calibration is running, the calibration gas switching outputs cannot be activated via remote control.)	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	[received command]
	Byte 7	[space character]
	Byte 8	[status character]
	Byte 9	[space character]
	Byte 10 ... 11	BS
	Byte 12	ETX
The received command does not match the command syntax.	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	[received command]
	Byte 7	[space character]
	Byte 8	[status character]
	Byte 9	[space character]
	Byte 10 ... 11	SE
	Byte 12	ETX
The received command is not defined.	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	????
	Byte 7	[space character]
	Byte 8	[status character]
	Byte 9	ETX

[1] see “Status character”, page 183.

10.5 Remote control commands

10.5.1 General commands

Command	*Activate the remote control*
Function	After this command, the S700 will execute all remote control commands which begin with S and E. (“A” commands can be executed without this activation.)
Command syntax	SREM
Transmitted reply	SREM [status character] (= command executed)

Command	*Deactivate the remote control*
Function	After this command the S700 will only execute control commands beginning with A as well as the command SREM. The S700 will reject other commands which begin with S or E.
Command syntax	SMAN
Transmitted reply	SMAN [status character] (= command executed)
	SMAN [status character] SMAN (= SREM not activated)

Command	*Abort procedure*
Function	The S700 terminates the procedure currently running (for example, calibration) and controls the switching outputs so that sample gas is fed.
Command syntax	SBRK
Transmitted reply	SBRK [status character] (= command executed)
	SBRK [status character] SMAN (= SREM not activated)

Command	*Read command status*
Function	The S700 sends information about the S-command just being executed.
Command syntax	ASTA
Transmitted reply	ASTA [status character] [actual command]
Reply examples	AKOW 0 SMGA (= measuring)
	AKOW 0 SSG3 (= last command was SSG3)
	AKOW 0 SATK SNGA (= automatic calibration is running, zero gas is switched on)

10.5.2 Status reading commands

Command	*Read measuring components and measuring ranges*
Function	The S700 sends the internal name of a measuring component and the related physical measuring range, user-selectable for a single component or for all components.
Command syntax	AKMP Kx x = 1 ... 5: number of the desired measuring component x = 0: all measuring components
	AKMP = same function as AKMP K0
Transmitted reply	AKMP [status character] [x] [y] [x] = identification of the measuring component [y] = end value of the related physical measuring range

Command	*Read measured values*
Function	The S700 sends the current measured value for a single component or for all measuring components.
Command syntax	AKONx x = number of the desired measuring component x = 0 or no x: all measuring components
Transmitted reply	AKON [status character] [x] [mv] ([x2] [mv2] [x3] [mv3] ...)
	AKON [status character] # (= currently no measured values)

Command	*Read device status*
Function	The S700 sends a coded status message.
Command syntax	AFLT
Transmitted reply	AFLT [status character] 00100001 00001000 00000000 ... (8 blocks of 8 bits, each block separated by a space character)

Command	*Read serial number*
Function	The S700 sends its own device number (see “Display of device data”, page 102).
Command syntax	AGNR
Transmitted reply	AGNR [status character] [x] [x] = serial number

Command	*Read menu language*
Function	The S700 sends a character as identification for the selected menu language (example: E = English).
Command syntax	ASPR
Transmitted reply	ASPR [status character] [character]

10.5.3 Calibration commands

Command	*Read time interval*
Function	The S700 sends the time interval which has been set for a particular function. (Currently only for “calibration” = start command SATK.)
Command syntax	AFDA [function start command]
Transmitted reply	AFDA [function start command] [Value1] [Value2] ...
	AFDA [function start command] SE (= there is no time interval for this function or the command was partially incorrect.)

Command	*Set time interval*
Function	Set test gas delay time (see page 161) and calibration measuring interval (see page 162)
Command syntax	EFDA SATK [x] [y] [x] = test gas delay time = 10 ... 180 (seconds) [y] = calibration measuring time = 2 ... 600 (seconds)
Transmitted reply	EFDA [status character] (= command executed)
	EFDA [status character] SMAN (= SREM is not activated)
	EFDA [status character] SE (= command was partially incorrect)

Command	*Read the settings for the calibration gases*
Function	The S700 sends the nominal values and the pump status which are set for a particular calibration gas.
Command syntax	AKNx x = 1 ... 2 = selected zero gas
	AKPy y = 3 ... 6 = selected test gas
Transmitted reply	AK... [status character] [pump status] [SW1] [SW2] [SW3] ... [SW...] = nominal value of the measuring component in % full scale of the physical measuring range (NO = “ -.- ” is set)

Command	*Read the settings for the calibration cuvette*
Function	The S700 sends the internal nominal values for the calibration cuvette.
Command syntax	AKKK
Transmitted reply	AKKK [status character] [pump status] [SW1] [SW2] [SW3] ... [SW...] = nominal values for the measuring components (internal units)
	AKKK [Status characters] SE (= there is no calibration cuvette in the analyzer)

Command	*Set values for calibration gases*
Function	Sets nominal values and pump status for the calibration gases. • The nominal values are only valid for the first automatic calibration (see “Different automatic calibration routines”, page 157). • The nominal values must be set for each calibration gas and for each measuring component used during the first automatic calibration. • A nominal value is either a value in % of the physical measuring range or NO. NO means this test gas will not be used for sensitivity calibration for a particular measuring component (corresponds to menu setting “ -.- ”). • If all of the nominal values are set to NO, then this calibration gas will not be used for an automatic calibration. • The [pump status] determines whether the gas pump (built-in or controlled by the S700) will remain switched on during delivery of the calibration gas to the analyzer. • This command cannot be used for an H_2O calibration because a special procedure must be used for the H_2O sensitivity calibration (see “Calibration of measuring component H_2O”, page 174).
Command syntax	EKNx [pump status] [SN1] [SN2] ... [SNn] x = 1 or 2 (for zero gas x) [SN...] = –20.0 ... 80.0 or NO
	EKPx [pump status] [SP1] [SP2] ... [SPn] x = 3, 4, 5 or 6 (for test gas x) [SP...] = 10.0 ... 120.0 or NO
	[pump status] = ON or OFF n = total number of measuring components
Transmitted reply	EK... [status character] (= command executed)
	EK... [status character] SMAN (= SREM not activated)
	EK... [status character] SE (= command partially incorrect)

Command	*Start an automatic calibration*
Function	The S700 runs an automatic calibration according to the settings for the first automatic calibration.
Command syntax	SATK
Transmitted reply	SATK [status character] (= command executed)
	SATK [status character] SMAN (= SREM not activated)
	SATK [status character] BS (= command cannot be executed because another procedure is running)

Command	*Read calibration results*
Function	The S700 sends the “absolute drifts” (see “Display of drift values”, page 103) for a particular measuring component. The values have been calculated during the last calibration.
Command syntax	AKOW Kx x = 1 ... 5 = number of the desired measuring component
Transmitted reply	AKOW [pump status] [x] [y] [x] = zero point drift (%) [y] = sensitivity drift (%)

Command	*Measure a calibration gas*
Function	The S700 controls the switching outputs for gases so that the desired calibration gas will be fed into the analyzer and measured in normal measuring mode.
Command syntax	SNGx x = 1 ... 2 = desired zero gas
	SPGx x = 3 ... 6 = desired test gas
Transmitted reply	S...G... [status character] (= command executed)
	S...G... [status character] SMAN (= SREM not activated)
	S...G... [status character] BS (= command cannot be executed because another procedure is currently running)

10.5.4 Measuring mode commands

Command	*Feed sample gas*
Function	The S700 controls the switching outputs in such a way that the sample gas will be fed to the analyzer and the analyzer is in its normal measuring mode.
Command syntax	SMGA
Transmitted reply	SMGA [status character] (= command executed)
	SMGA [status character] SMAN (= SREM not activated)
	SMGA [status character] BS (= command cannot be executed because another procedure is currently running)

10.5.5 Device identification commands

Command	*Read device identification*
Function	The S700 sends the programmed device identification.
Command syntax	AKEN
Transmitted reply	AKEN [status character] [device identification]

Command	*Set the device identification*
Function	The S700 saves the entered device identification. This [device ID] can consist of a maximum of 40 ASCII characters.
Command syntax	EKEN [device identification]
Transmitted reply	EKEN [status character] (= device ID saved)
	EKEN [status character] SE (= Command partially incorrect)
	EKEN [status character] SE (= Command partially incorrect)

10.5.6 Temperature compensation commands

Command	*Read the temperature compensation status*
Function	The S700 reports if the temperature compensation has been activated for a particular measuring component.
Command syntax	ATMP Kx x = 1 ... 5 = number of the desired measuring component
Transmitted reply	ATMP [status character] x ON (= temperature compensation active)
	ATMP [status character] x OFF (= temperature compensation not active)
	ATMP [status character] SE (= command partially incorrect)

Command	*Switch temperature compensation on/off*
Function	Activate or deactivate the temperature compensation for a particular component.
Command syntax	ETMP Kx [a] x = 1 ... 5 = number of the desired measuring component [a] = ON (activate) or OFF (deactivate)
Transmitted reply	ETMP [status character] (= command executed)
	ETMP [status character] SMAN (= SREM not activated)
	ETMP [status character] SE (= command partially incorrect)

11 Remote control with Modbus

11.1 Introduction to the Modbus protocol

Function

Modbus® is a communication standard for digital control systems, used to establish a connection between a “master” device and a number of “slave” devices. The Modbus protocol only defines the communication commands not their electronic transfer which means it can be used for different digital interfaces (for example, RS232, RS422, RS485). The Modbus standard was originally developed by the MODICON company for use with their interface controller chips; now it is a widely-used industrial application.

Versions

There are two Modbus transmission versions:

- *ASCII transfer mode:* Two ASCII characters (2 characters each with 4 bits) are sent in one byte (8 bits). It allows pauses between message characters (up to 1 second) without causing an error.
- *RTU transfer mode:* Two hexadecimal characters are sent as two characters each with 4 bits. The RTU mode can be faster.

Command structure

Device address (address)	Function code (function)	Function data (data)	Checksum (check sum)

- The device address is set individually for each connected device.
- Function codes are specific for Modbus. For example, these trigger the slave to output device data (Read) or to change internal states (Force).
- The function data contain the additional information required to perform the function. This information is device-specific, which means the data must be specified by the manufacturer. The function code and function data pair form the command the addressed slave should perform.
- The check sum is used to validate the transmitted data. The check sum is calculated by both the transmitting and the receiving device. If the results are identical, the data transmission was correct.

Slave’s Respond

Normally, the slave will respond to a command by sending an echo, with the same Function code, and with the Data containing the requested information. For error messages, the Function code is modified, and the Data contain an error code.

For more information on the Modbus protocol, visit the Modbus Internet website: http://www.modbus.org

11.2 Modbus specifications for the S700

Modbus functionality

- The S700 works as a slave device.
- The S700 uses the RTU mode for input and output transmission.
- The S700 responds to an input command immediately after the last command character has been received, without any delay. This is an deviation from the “Modicon Modbus Reference Guide” which specifies a “Silent Interval” in the RTU mode of 3.5 character times after each command.

Allowable Modbus parameters

▶ With a Baud rate of 9600 Baud, maintain the following Modbus parameters:

Slave response time:	200 ms
Delay between polls:	200 ms
Scan rate:	500 ms

▶ Set longer times for lower Baud rates.

Data transmission errors might occur with lower values.

The S700 takes approximately 0.5 seconds to generate a new measured value. When the S700 measures two measuring components, new measured values are created at intervals of approx. 1 second. It is probably not necessary to request measured values at shorter intervals.

11.3 Installation of a Modbus remote control

11.3.1 Interface

Interface #1 is used for the remote control (pin assignment, see “Plug connector X2 (interfaces)”, page 76). Permitted interface parameters:

Baud rate:	maximum 28800
Data bits:	8
Parity:	even/odd/none (as required)
Stop bits:	1

Settings, see “Digital interface parameters”, page 124.

11.3.2 Electrical connection

Connecting a single slave device

The Modbus functions can even be used with a simple direct interface connection, as shown on the left part of „Remote control with “AK protocol”“ (see page 182). In this way, a single S700 can be connected to a master device. e.g, for tests.

Connecting several slave devices (BUS mode)

When several S700 are to be controlled by one Master device, a BUS system with RS232C/ Bus converters must be installed as shown in the right part of „Remote control with “AK protocol”“ (see page 182). Other BUS systems can be used instead of RS422; for example, RS485.

11.3.3 Setting interface parameters (overview)

Basic settings

1 Adapt the interface parameters of interface #1 to the connected device[1].	see “Digital interface parameters”, page 124
2 Set-up the installed electrical connection type.	see “Setting the installed connection”, page 129

[1] For Modbus: bus converter or master device. Otherwise: PC, modem.

When using BUS converters (Modbus):

1 Activate the “RTS/CTS protocol”.	see “Digital interface parameters”, page 124
2 Set-up an individual identification character for each connected gas analyzer.	see “Setting the identification character”, page 128
3 Activate the effect of the identification character.	see “Activating the ID character / Activating Modbus”, page 129

When using BUS converters:
- Make all the remote control settings identical in all the connected gas analyzers – except for the identification character.

Operation with modems (general)

▶ Set-up the basic modem functions.	see “Configuring the modem connection”, page 130

11.4 Modbus function commands for the S700

11.4.1 Function codes

The S700 can process the following function codes:

Table 16:

Code	Description	Function
01	Read Coil Status	Read one or several 1-bit status information (in order to request the S700 status).
		A maximum of 64 coils can be read per command. 200 coils are available (see “Modbus read commands”).
		Address: 0000H to 00C7H
03	Read Holding Register	Read one or several 16-bit data words.
		A maximum of 32 registers can be read with one command. 200 registers available of 16 bits each (see “Modbus read commands”).
		Address: 0000H to 00C7H
05	Force Single Coil	Write a 1-bit information (in order to program one S700 setting).
		Each command can change 1 coil. 32 coils are available (see “Modbus control commands”).
		Addresses: 0000H ... 001FH (overlapping with Read Coil Status) and 00A8H ... 00C7H (is being reset after power failure).
16	Preset Multiple Register	Write one or several 16-bit data words (in order to program a S700 setting).
		Each command allows to write a maximum of 32 registers. 32 Register available (see “Modbus control commands”).
		Addresses: 0000H ... 001FH (overlapping with Read Holding Register) and 00A8H ... 00C7H (reset after power failure).

Modbus commands with other function codes will be ignored.

11.4.2 Data formats

Data format for function values (status information)

A digital value is just 1 bit:

- Logical 0 = function OFF
- Logical 1 = function ON

A data byte consists of 8 bits with 8 digital values:

- Bit 0 = least significant bit (lowest digital value)
- Bit 7 = most significant bit (highest digital value)

Data format for floating-point values

A floating-point value consists of two 16-bit data words (2x 16 Bit = 4 Byte):

Byte 3 (MSB)	Byte 2	Byte 1	Byte 0 (LSB)
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM

S = Sign; 0 = + / 1 = –
E = Exponent (2 complements biased by 127)
M = Mantissa (1st mantissa)

Order of data transmission:

Byte 1	Byte 0 (LSB)	Byte 3 (MSB)	Byte 2

11.4.3 Modbus control commands

Force Single Coil

Using the control command Force Single Coil (function code 05) and its subsequent function data, the master device can control the following functions of the S700 :

Data	Control command
1	– not specified –
2	– not specified –
3	– not specified –
4	– not specified –
5	sample hold (20 mA measured value outputs)
6	switch-off pump
7	activate service lock
8	stop/disable automatic calibrations
9	start automatic calibration 1
10	start automatic calibration 2
11	start automatic calibration 3
12	start automatic calibration 4
13	Measured value output 1: activate range 2
14	Measured value output 2: activate range 2
15	Measured value output 3: activate range 2
16	Measured value output 4: activate range 2

Data	Control command
17	hold sampling point 1
18	hold sampling point 2
19	hold sampling point 3
20	hold sampling point 4
21	hold sampling point 5
22	hold sampling point 6
23	hold sampling point 7
24	hold sampling point 8
25	skip sampling point 1
26	skip sampling point 2
27	skip sampling point 3
28	skip sampling point 4
29	skip sampling point 5
30	skip sampling point 6
31	skip sampling point 7
32	skip sampling point 8

Preset Multiple Register

Using the control command Preset Multiple Register (function code 16) and its subsequent register data, the master device can control the following S700 functions:

Register no.		Control command	Structure			
X	Y		X-high	X-low	Y-high	Y-low
R1	R2	set date in the S700	month	day	– free –	year
R3	R4	set time in the S700	hours	minutes	– free –	seconds
R5	R6	set AK-ID/Modbus mode	mode code [1]		– free –	– free –
R7	R8	– not specified –				
R9	R10	– not specified –				
R11	R12	– not specified –				
R13	R14	– not specified –				
R15	R16	– not specified –				
R17	R18	– not specified –				
R19	R20	– not specified –				
R21	R22	– not specified –				
R23	R24	– not specified –				
R25	R26	– not specified –				
R27	R28	– not specified –				
R29	R30	– not specified –				
R31	R32	– not specified –				

[1]0 = “without AK-ID” / 1 = “with AK-ID” / 2 = “with AK-ID MODBUS” (see “Activating the ID character / Activating Modbus”, page 129)

11.4.4 Modbus read commands

Read Coil Status

Using the Read Coil Status command (function code 01) and its subsequent function data, the master device can read the S700 device status:

Data	Status
0	maintenance active
1	temp. controller 1 is heating up
2	temp. controller 1 is out of the nominal range
3	temp. controller 2 is heating up
4	temp. controller 2 is out of the nominal range
5	temp. controller 3 is heating up
6	temp. controller 3 is out of the nominal range
7	controller 4 is starting-up
8	controller 4 is out of the nominal range
9	MULTOR filter wheel: Index mark not found
10	alarm limit 1 indication is activated
11	alarm limit 2 indication is activated
12	alarm limit 3 indication is activated
13	alarm limit 4 indication is activated
14	signal for compon. 1 too high (ADC overflow)
15	signal for compon. 2 too high (ADC overflow)
16	signal for compon. 3 too high (ADC overflow)
17	signal for compon. 4 too high (ADC overflow)
18	signal for compon. 5 too high (ADC overflow)
19	A/D converter (ADC) is not ready
20	meas. value compon. 1 > 120 % of end val.[1]
21	meas. value compon. 2 > 120 % of end val.[1]
22	meas. value compon. 3 > 120 % of end val.[1]
23	meas. value compon. 4 > 120 % of end val.[1]
24	meas. value compon. 5 > 120 % of end val.[1]
25	calibration running
26	automatic calibration running
27	control output “zero gas path 1” is activated
28	control output “sample gas path” is activated
29	control output “test gas path 3” is activated
30	control output “test gas path 4” is activated
31	control output “test gas path 5” is activated
32	Measured value output 1: activate range 2 is active
33	Measured value output 2: activate range 2 is active
34	Measured value output 3: activate range 2 is active
35	Measured value output 4: activate range 2 is active
36	control output “external pump” is activated
37	zero point drift of compon. 1 > drift limit
38	zero point drift of compon. 2 > drift limit
39	zero point drift of compon. 3 > drift limit
40	zero point drift of compon. 4 > drift limit
41	zero point drift of compon. 5 > drift limit
42	sensitivity drift of compon. 1 > drift limit
43	sensitivity drift of compon. 2 > drift limit
44	sensitivity drift of compon. 3 > drift limit
45	sensitivity drift of compon. 4 > drift limit
46	sensitivity drift of compon. 5 > drift limit
47	zero pt. drift of compon. 1 > 120 % drift limit
48	zero pt. drift of compon. 2 > 120 % drift limit
49	zero pt. drift of compon. 3 > 120 % drift limit
50	zero pt. drift of compon. 4 > 120 % drift limit
51	zero pt. drift of compon. 5 > 120 % drift limit
52	sens. drift of compon. 1 > 120 % drift limit
53	sens. drift of compon. 2 > 120 % drift limit
54	sens. drift of compon. 3 > 120 % drift limit
55	sens. drift of compon. 4 > 120 % drift limit
56	sens. drift of compon. 5 > 120 % drift limit
57	pressure signal too great (ADC overflow)
58	condensate in sample gas path (int. sensor)
59	flow signal too great (ADC overflow)
60	flow < flow limit value (failure)
61	flow < flow limit value (fault)

Data	Status
62	control input “test gas 3 fault” is activated
63	control input “test gas 4 fault” is activated
64	control input “test gas 5 fault” is activated
65	control input “zero gas 1 fault” is activated
66	IR source malfunction
67	chopper wheel malfunction
68	failure during calibration with zero gas 1
69	failure during calibration with test gas 3
70	failure during calibration with test gas 4
71	failure during calibration with test gas 5
72	failure during calibration with cal. cuvette
73	internal power supply failure
74	control input “failure 1” is activated
75	control input “failure 2” is activated
76	control input “fault 1” is activated
77	control input “fault 2” is activated
78	control input “service 1” is activated
79	control input “service 2” is activated
80	“FAULT” status is activated
81	“SERVICE” status is activated
82	control output “zero gas path 2” is activated
83	control output “test gas path 4” is activated
84	control input “zero gas 2 fault” is activated
85	control input “test gas 6 fault” is activated
86	failure during calibration with zero gas 2
87	failure during calibration with test gas 6
88	sampling point 1 is activated
89	sampling point 2 is activated
90	sampling point 3 is activated
91	sampling point 4 is activated
92	sampling point 5 is activated
93	sampling point 6 is activated
94	sampling point 7 is activated
95	sampling point 8 is activated
96	measured values belong to sampling point 1
97	measured values belong to sampling point 2
98	measured values belong to sampling point 3
99	measured values belong to sampling point 4
100	measured values belong to sampling point 5
101	measured values belong to sampling point 6
102	measured values belong to sampling point 7
103	measured values belong to sampling point 8
104	analyzer module 1 is out of order
105	analyzer module 2 is out of order
106	analyzer module 3 is out of order
107	analog input 1 is out of order
108	analog input 2 is out of order
109	analyzer module 1 malfunction
110	analyzer module 2 malfunction
111	analyzer module 3 malfunction
112	analog input 1 malfunction
113	analog input 2 malfunction
114	calibration running with analyzer module 1
115	calibration running with analyzer module 2
116	calibration running with analyzer module 3
117	calibration running with analog input 1
118	calibration running with analog input 2
119	signal of an. module 1 is too great (ADC overfl.)
120	signal of an. module 2 is too great (ADC overfl.)
121	signal of an. module 3 is too great (ADC overfl.)
122	signal of an. module 4 is too great (ADC overfl.)
123	signal of an. module 5 is too great (ADC overfl.)

[1]The physical measuring range.

Read Coil Status

With a Read Coil Status command and its subsequent function data, the master device can check whether the S700 has received and processed the related "Force Single Coil" control command:

Data	Control command
169	– not specified –
170	– not specified –
171	– not specified –
172	– not specified –
173	sample hold (20 mA measured value outputs)
174	switch-off pump
175	activate service lock
176	stop/disable automatic calibrations
177	start automatic calibration 1
178	start automatic calibration 2
179	start automatic calibration 3
180	start automatic calibration 4
181	Measured value output 1: activate range 2
182	Measured value output 2: activate range 2
183	Measured value output 3: activate range 2
184	Measured value output 4: activate range 2

Data	Control command
185	hold sampling point 1
186	hold sampling point 2
187	hold sampling point 3
188	hold sampling point 4
189	hold sampling point 5
190	hold sampling point 6
191	hold sampling point 7
192	hold sampling point 8
193	skip sampling point 1
194	skip sampling point 2
195	skip sampling point 3
196	skip sampling point 4
197	skip sampling point 5
198	skip sampling point 6
199	skip sampling point 7
200	skip sampling point 8

In the response, status "1" means "function is activated" and status "0" means "function is not activated". After power failure or switching-off the S700, the status of these messages is "not activated".

Read Holding Register

With a Read Holding Register command (function code 03) and subsequent function data, the master device can read the following values from the S700:

Register no.		Status/value	Structure			
X	Y		X-high	X-low	Y-high	Y-low
R1	R2	current date (in the S700)	month	day	– free –	year
R3	R4	current time (in the S700)	hours	minutes	– free –	seconds
R5	R6	measuring component 1: current measured value	floating-point value			
R7	R8	measured component 1: end value of physical measuring range.	floating-point value			
R9	R10	date of the last zero point calibration	month	day	– free –	year
R11	R12	time of the last zero point calibration	month	day	– free –	year
R13	R14	Measuring component 1: current zero point drift in %	floating-point value			
R15	R16	date of the last sensitivity calibration	month	day	– free –	year
R17	R18	time of the last sensitivity calibration	month	day	– free –	year
R19	R20	measuring component 1: current sensitivity drift in %	floating-point value			
R21	R22	Measuring component 1: current zero point drift in %	floating-point value			
R23	R24	measuring component 1: previous sensitivity drift in %	floating-point value			
R25	R26	– not specified –				
R27	R28	– not specified –				
R29	R30	– not specified –				
R31	R32	current date (in the S700)	month	day	– free –	year
R33	R34	current time (in the S700)	hours	minutes	– free –	seconds
R35	R36	measuring component 2: current meas. value	floating-point value			
R37	R38	measuring component 2: end value of physical range.	floating-point value			
R39	R40	date of the last zero point calibration	month	day	– free –	year
R41	R42	time of the last zero point calibration	month	day	– free –	year
R43	R44	Measuring component 2: current zero point drift in %	floating-point value			
R45	R46	date of the last sensitivity calibration	month	day	– free –	year
R47	R48	time of the last sensitivity calibration	month	day	– free –	year
R49	R50	meas. comp. 2: current sensitivity drift in %	floating-point value			
R51	R52	Measuring component 2: current zero point drift in %	floating-point value			
R53	R54	meas. comp. 2: previous sensitivity drift in %	floating-point value			
R55	R56	– not specified –				
R57	R58	– not specified –				
R59	R60	– not specified –				

R61	R62	current date (in the S700)	month	day	– free –	year
R63	R64	current time (in the S700)	hours	minutes	– free –	seconds
R65	R66	measuring component 3: current meas. value	floating-point value			
R67	R68	meas. comp. 3: end value of physical range	floating-point value			
R69	R70	date of the last zero point calibration	month	day	– free –	year
R71	R72	time of the last zero point calibration	month	day	– free –	year
R73	R74	Measuring component 3: current zero point drift in %	floating-point value			
R75	R76	date of the last sensitivity calibration	month	day	– free –	year
R77	R78	time of the last sensitivity calibration	month	day	– free –	year
R79	R80	meas. comp. 3: current sensitivity drift in %	floating-point value			
R81	R82	Measuring component 3: current zero point drift in %	floating-point value			
R83	R84	meas. comp. 3: previous sensitivity drift in %	floating-point value			
R85	R86	– not specified –				
R87	R48	– not specified –				
R89	R90	– not specified –				
R91	R92	current date (in the S700)	month	day	– free –	year
R93	R94	current time (in the S700)	hours	minutes	– free –	seconds
R95	R96	meas. comp. 4: current meas. value	floating-point value			
R97	R98	meas. comp. 4: end value of physical range.	floating-point value			
R99	R100	date of the last zero point calibration	month	day	– free –	year
R101	R102	time of the last zero point calibration	month	day	– free –	year
R103	R104	Measuring component 4: current zero point drift in %	floating-point value			
R105	R106	date of the last sensitivity calibration	month	day	– free –	year
R107	R108	time of the last sensitivity calibration	month	day	– free –	year
R109	R110	meas. comp. 4: current sensitivity drift in %	floating-point value			
R111	R112	Measuring component 4: current zero point drift in %	floating-point value			
R113	R114	meas. comp. 4: previous sensitivity drift in %	floating-point value			
R115	R116	– not specified –				
R117	R118	– not specified –				
R119	R120	– not specified –				
R121	R122	current date (in the S700)	month	day	– free –	year
R123	R124	current time (in the S700)	hours	minutes	– free –	seconds
R125	R126	measuring component 5: current meas. value	floating-point value			
R127	R128	meas. comp. 5: end value of physical range.	floating-point value			
R129	R130	date of the last zero point calibration	month	day	– free –	year
R131	R132	time of the last zero point calibration	month	day	– free –	year
R133	R134	Measuring component 5: current zero point drift in %	floating-point value			
R135	R136	date of the last sensitivity calibration	month	day	– free –	year
R137	R138	time of the last sensitivity calibration	month	day	– free –	year
R139	R140	meas. comp. 5: current sensitivity drift in %	floating-point value			
R141	R142	Measuring component 5: current zero point drift in %	floating-point value			
R143	R144	meas. comp. 5: previous sensitivity drift in %	floating-point value			
R145	R146	– not specified –				
R147	R148	– not specified –				
R149	R150	– not specified –				
R151	R152	pressure [hPa] (meas. value of int. sensor)	floating-point value			
R153	R154	flow [l/h] (measured value of internal sensor)	floating-point value			
R155	R156	temperature [°C] for int. temp. compensation	floating-point value			
R157	R158	IR source supply voltage [V]	floating-point value			
R159	R160	signal input 1 [V]	floating-point value			
R161	R162	signal input 2 [V]	floating-point value			
R163	R164	– not specified –				
R165	R166	– not specified –				
R167	R168	– not specified –				
R169	R170	“set current date” command received	month	day	– free –	year
R171	R172	“set current time” command received	hours	minutes	– free –	seconds
R173	R174	“set AK-ID/Modbus mode” command received	mode code [1]		– free –	– free –
R175	R176	– not specified –				
R175 to R199	R176 to R200	– not specified –				

[1]0 = “without AK-ID” / 1 = “with AK-ID” / 2 = “with AK-ID MODBUS” (see “Activating the ID character / Activating Modbus”, page 129)

12 Maintenance

12.1 General safety information

CAUTION: Risks during maintenance work

- *If it is necessary to open the device for setting or repair:* Disconnect the device from all power sources before starting work.
- *If the open device must be live during work:* This work must be performed by skilled persons familiar with potential hazards. Live parts could be exposed when it is necessary to remove or open internal components.
- Never interrupt protective conductor connections.
- Further hazards see “Safety information on disassembly of components”, page 196.

12.2 Safety information in potentially explosive atmospheres

DANGER: Risk of explosion due to improper execution of the work described in these Operating Instructions.

Improper execution of work in the potentially explosive atmosphere can cause serious damage to people and the plant.

- Maintenance and inspection should only be carried out by experienced/trained personnel with knowledge of the rules and regulations for potentially explosive atmospheres, especially:
  - Ignition protection types
  - Installation regulations
  - Zone classification

12.3 Safety information on disassembly of components

12.3.1 Health protection, decontamination

WARNING: Hazard through sample gas and its residues

Hazard through contact with sample gas dangerous to health

Before opening device components with sample gas contact or disassembling the device, observe:

- The enclosure can be contaminated with sample gas dangerous to health when the gas path has a leak.
- Take suitable protective measures (for example, Safety Data Sheet, breathing protection, gloves, clothes (acid resistant as necessary), suctioning off).
- *In case of contact of skin or eyes with contaminated part:* Follow instructions of the respective Safety Data Sheet and consult a doctor.
- Observe cleaning instructions; contact Endress+Hauser Customer Service when necessary.
- Interrupt gas supply to the unit; exception: purge gas supply (if present).
- Remove sample gas residues: Purge all parts carrying sample gas with inert gas for a sufficiently long time (depending on the application).
- Remove solid and liquid residues.

CAUTION: Toxic sample gases

Environment and health hazards through toxic sample gases

The sample gas filter of the gas sampling probe can be contaminated in processes using toxic sample gas:

- Use suitable protective equipment.
- Stop gas feed to the device before removing the sample gas filter.
- Dispose of filter remnants in an environmentally compatible manner and according to the specific waste disposal regulations of your country.

CAUTION: Toxic gases in test cuvette

Environment and health hazards through toxic sample gases

Depending on the application, the test cuvettes can contain a small amount of toxic gases.

- The test cuvettes are located on the filter wheel.
- Do not destroy test cuvettes directly in front of your face and do not directly inhale emerging gases.
- Do not destroy test cuvettes in small, closed rooms, especially when large quantities must be destroyed.
- Dispose of test cuvettes in an environmentally compatible manner and according to the specific waste disposal regulations of your country.

WARNING: Health risk through dangerous gases in the enclosure

A small amount of dangerous gas may be enclosed in the analyzer modules. When the component becomes leaky, this amount of gas escapes into the enclosure (possible gases and amounts (see Table)17).

To prevent danger through such a gas:

- *Before opening the enclosure (especially when an internal defect is suspected):* Ensure breathing protection (for example, adequate ventilation/suctioning off).
- Also check the state of the internal components during regular maintenance measures (see “Maintenance plan”, page 198). Repair components which seem to be damaged or are questionable.

Table 17: Dangerous gases in analyzer modules

Analyzer module	Possibly enclosed gas	Maximum gas amount	Maximum gas concentration in the enclosure in case of a defect
UNOR MULTOR	$CO \cdot NO \cdot NO_2 \cdot SO_2 \cdot NH_3 \cdot N_2O$ · hydrocarbons · freon	50 ml	1000 ppm

12.3.2 Possible hazard through IR radiation

WARNING: Hazard through laser radiation

Retina damage when eyes are exposed to radiation

Depending on the device type, eyes can be damaged by radiation.

- Disconnect the power supply before opening the device.
- Do not hold reflecting or focusing objects in the light beam (for example, glass).

12.3.3 Repairs to explosion-proof devices

Valid for S715 Ex, S715 Ex CSA, S720 Ex, S721 Ex

WARNING: Risk of explosion when using spare or expendable parts not approved for the Ex-area

All spare and wear parts for the measuring device are tested by Endress+Hauser for use in Ex-areas. The use of other spare and expendable parts will invalidate the claim against Endress+Hauser because the ignition protection cannot be guaranteed.

- Use only original spare parts and wear and tear parts from Endress+Hauser .
- Repairs and modifications to components relevant to ignition protection (for example, flame arresters) may only be carried out by the manufacturer.

12.4 Maintenance plan

Table 18: Maintenance plan

Maintenance interval	Maintenance work	
1 ... 2 days	▶ Make a visual inspection.	see “Visual check”, page 199
1 week ... 1 month	▶ Run calibrations (except for H_2O).	see “Manual calibration”, page 153 see “Automatic calibrations”, page 156
	▶ Check sensitivity drift of OXOR-E module. [1]	see “Setting the drift limit values”, page 160
	▶ Check important signal connections.	see “Testing the electrical signals”, page 200
	▶ Check the flow monitor. [2]	[3]
3 months	▶ Check the gas lines for leaks. – For hazardous gases	see “Leak tightness check of sample gas path”, page 201
approx. 6 months	▶ Check the gas lines for leaks.	see “Leak tightness check of sample gas path”, page 201
	▶ Check/change the internal safety filter.	[4]
	▶ Check the built-in gas pump. [2]	[4]
approx. 1 year	▶ Perform a H_2O calibration. [2]	see “Calibration of measuring component H_2O”, page 174
1 ... 2 years	▶ Perform a full calibration. [5]	see “Full calibration”, page 167
1 ... 5 years	▶ Replace the OXOR-E module. [2]	see “Replacing the O_2 sensor in the OXOR-E module”, page 205

[1] Only for analyzers equipped with the analyzer module OXOR-E
[2] Only for analyzers equipped with this feature
[3] Reduce sample gas flow to the S700 and check for fault indication (see “Setting the flow monitor limit value”, page 137).
[4] Should be performed by a service technician or trained skilled persons.
[5] Only for analyzers working with internal cross-sensitivity compensation

In addition, please observe all official and internal company regulations valid for your application.

12.5 Visual check

Function

A visual inspection serves to check the operating state of the analyzer.

WARNING: Accident risk
Risk of injury through unsafe operating state
When damage is visible or liquid has penetrated the device:
- ▶ Disconnect the power voltage at an external location.
- ▶ Disconnect the gas feed.
- ▶ Secure the device against unintentional switching on.
- ▶ Repair or exchange the device.

Maintenance interval

Recommendation: Max. 2 days

Procedure

- *S700:*

– LED Function: Should continuously light *green*.
When Function lights red: Observe status messages on the display (information, see “Status messages (in alphabetical order)”, page 211).
– LED Service: Should *not* light.
When Service lights: Observe status messages on the display (information, see “Status messages (in alphabetical order)”, page 211).

- *Peripherals:*

– Check all external devices (for example: gas filter, sample gas cooler, converter).
– Check the gas lines (state, connections).
– When calibration gases are fed automatically: Check state and availability of the calibration gases (for example, delivery pressure from the central gas supply, remaining quantity in the gas cylinders, expiration date).

In potentially explosive atmospheres:

– Check the state of the connection cables.

WARNING: Risk of explosion through damaged connection cables
In potentially explosive atmospheres: All connection cables must be intact and correctly installed.
- ▶ Also check the state of the connection cables during a visual check.

When a cable is damaged:
- ▶ Take the S700 out of operation (and/or do not start-up).
- ▶ Replace the damaged cable. [1]

[1] S720 Ex/S721 Ex: The connection cable of the display housing must only be replaced by an original spare part.

12.6 Testing the electrical signals

Function

If you are using the S700 to give an alarm in case of a dangerous operating state or to control important processes, then you should regularly check that all electrical functions and connections are working correctly.

Maintenance interval

Recommendation: Max. 1 month

Procedure

1. Check if the external processing of the S700 signals should be deactivated (for example: measured value signals, control signals). If so, carry out the necessary measures.
2 Inform the connected stations that you intend to make a test.
3 Use the `hardware test` functions to test all important S700 electrical signals (see “Testing electronic outputs (hardware test)”, page 144).

12.7 Leak tightness check of sample gas path

12.7.1 Safety notes on leak tightness

WARNING: Hazards caused by leaky gas lines

- If the sample gas is poisonous or harmful, a danger to health exists if the gas path is leaky.
- If the sample gas is corrosive or can create corrosive liquids with water (for example, with air humidity), then escaping sample gas might cause damage to the gas analyzer and proximate devices.
- If the escaped gas can create an explosive gas mixture with the ambient air, risk of explosion occurs if the safety precautions against explosion hazards have not been maintained.
- If the gas path is leaky, then the measured values are possibly wrong.

If the gas path is noticed to be leaky:

- ▶ Stop the gas feed.
- ▶ Take the gas analyzer out of operation.
- ▶ *If the escaping gas can be dangerous to health, corrosive or combustible:* Remove the escaping gas systematically (purge, suction off, vent) whilst maintaining the necessary safety measures, for example, for
  - explosion prevention (for example, purge the enclosure with neutral gas)
  - health protection (for example, wear respiratory equipment)
  - pollution control

Leak tightness check of the S715 enclosure, see “Leak tightness check for the enclosure S715 Ex”, page 203.

12.7.2 Test criteria for gas-tightness

- For the stated test gas pressure (see Table)19, the leak rate of the internal gas path of the gas analyzer must not be higher than $3.75 \cdot 10^{-3}$ mbar · l/s. Otherwise, the gas analyzer must be considered leaky.
- Recommended test interval: Max. 6 months.

Table 19: Test gas pressure for the leak tightness check of the sample gas path

Version of the internal gas path	Test pressure
Hosed	450 mbar
Tubes – without analyzer module “OXOR-E”	1,5 bar
Tubed– with analyzer module “OXOR-E”	450 mbar

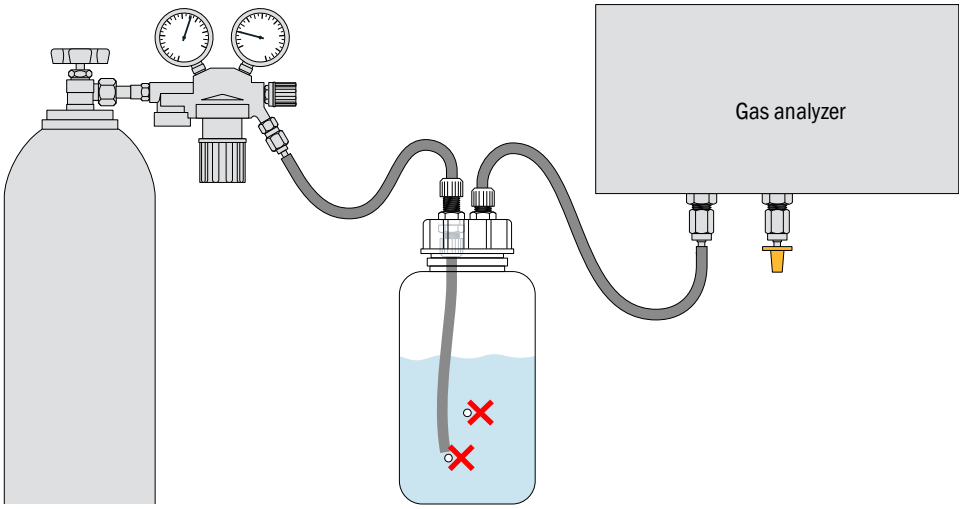
12.7.3 A simple leak test method

Test equipment

For a simple test, you need

- a compressed gas cylinder with adjustable pressure reducer (recommendation: Nitrogen)
- A »washing bottle« with two hose connections (see Fig. 30, page 202).
  - The washing flask must withstand the test pressure and must close gas-tight.
  - The outlet diameter of the hose (or tube) which extends into the water should be 4 mm (0.2 inch).
  - Ordinary water can be used for the filling. Set-up a filling level where no water can escape through the gas connections.

Fig. 30: A simple leak test method (example)



Test procedure

If the gas analyzer is equipped with several separate internal gas paths:
▶ Carry out this procedure once for each individual gas path.

1. Take the gas analyzer out of operation. Disconnect the gas inlet and outlet of the gas analyzer from the connected installations (if existing).
2 Connect the gas inlet of the analyzer to the gas outlet of the washing flask.
3 Close the gas analyzer gas outlet off gas-tight, for example, with a sealing plug.
4 Seal all the other gas connections of the internal gas path (if existing) in the same way.
5 Check: The valve on the pressure reducer gas outlet must be closed off. Then open the main valve of the gas cylinder.
6 Adjust the pressure reducer so that the output pressure (secondary pressure) corresponds to the test pressure (see Table 19, page 201).
7 Connect the gas outlet of the pressure reducer to the gas inlet of the washing flask.
8 *Slowly* open the outlet valve of the pressure reducer (avoid pressure shock).
9 Wait until the pressure in the test system is constant (may take some seconds).
10 Observe the washing flask for 3 minutes.
If no air bubbles rise during this time, the gas path is considered tight.
11 To finish the test:
   – Shut the outlet valve of the pressure reducer.
   – To release the gas pressure: Carefully loosen the connection hose *on the washing flask gas outlet*.
   – Refit all the regular gas connections of the analyzer – wpay particular attention to gas-tightness.

12.8 Leak tightness check for the enclosure S715 Ex

WARNING: Risk of explosion through leaky enclosure
When the enclosure of the S715 Ex had been opened, check that the enclosure is closed off as a “restricted breathing enclosure” before start-up.
- ▶ Check the state of the enclosure seals before closing the enclosure.
- ▶ After closing the enclosure, perform a leak tightness check.
- ▶ Do not start up the S715 Ex when the enclosure has not passed the leak tightness check.

WARNING: Risk of explosion through defective enclosure seals
The explosion protection of the enclosure is only ensured when all enclosure seals are correctly installed and intact.
- ▶ *Before closing the enclosure:* Check the state of the enclosure seals.
- ▶ Have damaged seals replaced by the manufacturer's Customer Service.

Check of internal leak tightness, see “Leak tightness check of sample gas path”, page 201.

Versions

Depending on the enclosure design, the upper and lower enclosure sections are separated or connected gas-tight. If the enclosure sections are separated gas-tight, there are 2 test connections for the leak test.

▶ Check the number of test connections (see Fig. 31, page 204):

1 test connection:	2 test connections:
▶ Perform the procedure as described.	▶ Perform the procedure once with each test connection.

Procedure

1. Prepare the test connection:
   – Remove the closure cap (screw cap) of the pressure connection (see Fig. 31, page 204).
   – Install the delivered hose connection (with cap nut) in place of the closure cap.
2. Connect a pressure gauge to the hose connection (measuring range should cover 0 ... -300 Pa) as well as a device which can be used to create a partial vacuum of 300 Pa (3 mbar) against the ambient pressure (for example, a pump) in the S715 Ex.
3. Create a partial vacuum of 300 Pa (3 mbar) in the S715 Ex. Then stop and close off the gas feed and read the manometer.

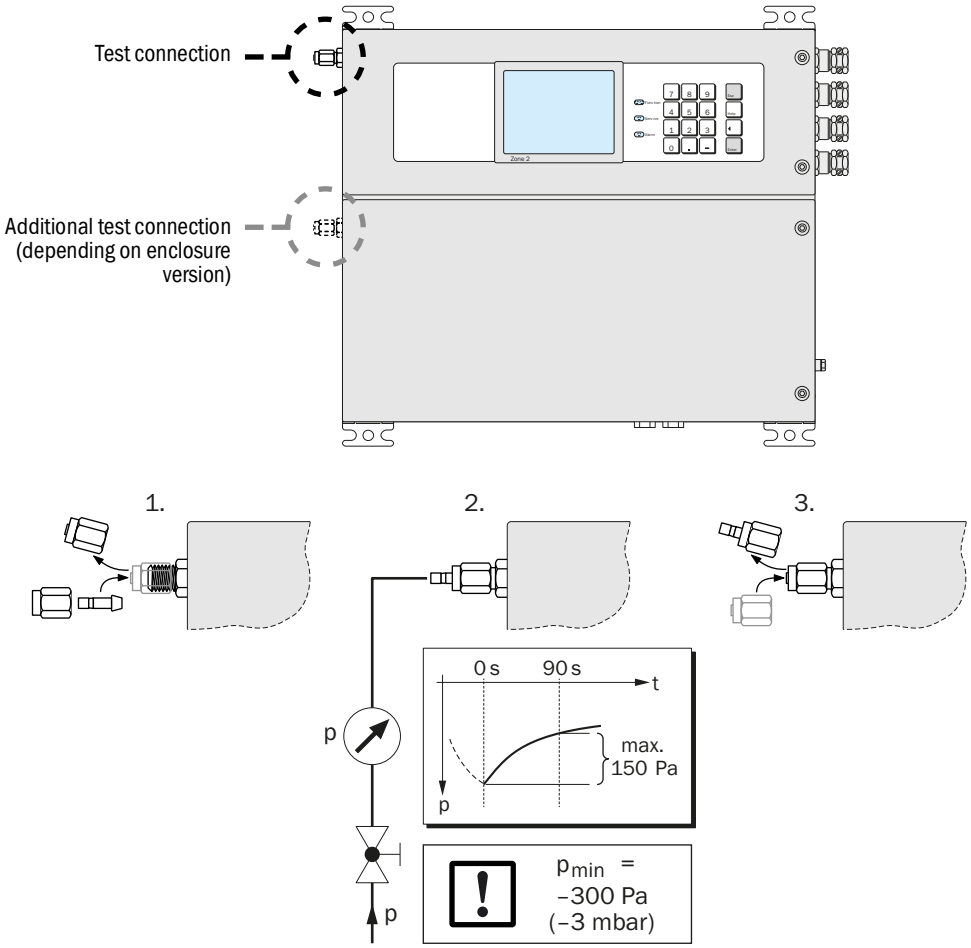
Damage to the enclosure
A higher pressure difference can damage the enclosure.
- ▶ Do not use a pressure above the specified pressure.

Although the pressure difference is small, it may take some minutes to establish the required pressure difference.

4. After 90 seconds, read the manometer again:

Pressure has risen no more than 150 Pa	Pressure has risen by more than 150 Pa
Test passed. 1 Remove the test installations. 2 Wait until the pressure has fully escaped the enclosure. 3 Reinstall the sealing cap so that it is gas-tight. The S715 Ex can now be put into operation.	Test has failed. 1 Check the sealing of the enclosure (sealings, cable inlets, closing caps). 2 Then perform the test again.

Fig. 31: Leak tightness check in Zone 2 for S715 Ex



12.9 Replacing the O_2 sensor in the OXOR-E module

Only applies for the S700 with the analyzer module OXOR-E *(see "Analyzer modules for O_2 measurement", page 30)*.

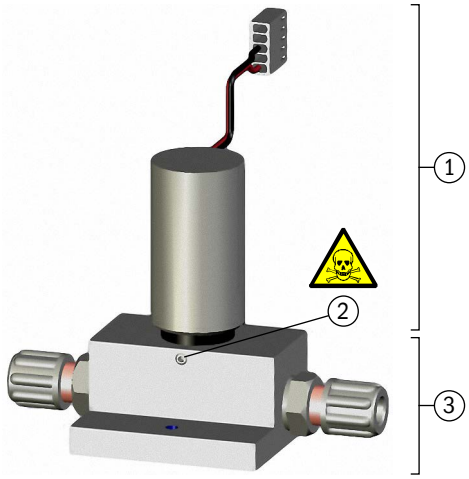
Maintenance interval

The analyzer module OXOR-E consists of an electrochemical O_2 sensor and a base with hose connections. Due to the measuring principle, the expected life of the O_2 sensor is limited. The following criteria indicate when the service life has ended:

- The response time of the O_2 measurement is permanently increasing.
- The O_2 sensitivity is rapidly decreasing, which means the O_2 sensitivity drift is rapidly increasing (see "Display of drift values", page 103).

- *Recommendation:* As a preventive measure, renew the O_2 sensor after about two years operating time.
- You can automatically monitor the O_2 sensitivity drift by setting a suitable drift limit value for the O_2 measurement (see "Setting the drift limit values", page 160).

Fig. 32: Analyzer module OXOR-E



1 O_2 sensor
2 Clamping screw
3 Base

Procedure

WARNING: Health risk through dangerous gases
If the sample gas contains poisonous or dangerous components:
▶ Thoroughly purge all sample gas paths with a neutral gas (for example, with nitrogen) before opening any gas paths or parts with sample gas contact.

1. Stop the sample gas flow to the S700 (close valve / switch off the pump) and take the S700 out of operation.
2. Open the S700:
   - S710/S711: Remove the enclosure cover on the top.
   - S715: Open the lower part of the enclosure.
   - S720 Ex/S721 Ex: Open the analyzer enclosure (procedure and safety information, see "Opening and closing the enclosure", page 55).
3. Inside, disconnect the connection cable of the O_2 sensor (plug connection).
4. Loosen the clamping screw of the O_2 sensor.
5. Pull the O_2 sensor out of the base.

6 Check the sealing ring and the sealing surfaces.

CAUTION: Risks through incorrect assembly
The connection between O_2 sensor and base has to be gas-tight:
- ▶ Make sure the O-ring (sealing ring) is intact.
- ▶ Make sure sealing surfaces are clean and dust-free.

Otherwise sample gas could escape during operation and the measurements could be erroneous.

To simplify fitting: Apply a thin film of high vacuum grease (silicone, water, Teflon) to the sealing ring. Do not use any other liquid or material.

7 Insert the new O_2 sensor into the base (to the mechanical stop).
8 Fix the module with the clamping screw.
9 Connect the connection cable of the O_2 sensor to the electronic board (→ X20).
10 Close the enclosure and restart the S700. Wait for an appropriate warm-up time. Then restart the sample gas flow.
11 Run a basic calibration for O_2 (see page 168).

Disposal

The O_2 sensor contains acid. Dispose of the spent O_2 sensors in the same manner as batteries.

Spare parts

Part No.	Description	Remarks
2071139	ET-OXOR-E Consumable parts set for retrofit set	= O_2 sensor (without base)
2071115	OXOR-E, hosed (retrofit set)	= complete OXOR-E module (O_2 sensor + base

NOTE:
Long storage periods shorten the service life of the O_2 sensor.
- ▶ Store the O_2 sensor as cool as possible.
- ▶ Maintain the allowable storage temperature: –20 … +60 °C.

12.10 Cleaning the enclosure

- Only use a moist, antistatic cloth to clean the enclosure.
- Do not use any mechanically or chemically aggressive cleaning agents.
- Do not allow any liquids into the enclosure.

CAUTION: Hazardous situation when liquids enter the enclosure

If liquids have entered the device:

- Do not touch the device any more.
- Immediately take the device out of operation by disconnecting the power at an *external* point (for example, pull out the power plug at the socket or switch off the external mains fuse).
- Contact the manufacturer's Customer Service or trained skilled persons able to repair the device.

13 Troubleshooting

13.1 If the S700 does not work at all ...

CAUTION: Health risks

▶ *Before any measures are taken inside the S700:* Observe the general safety notes (see “General safety information on installation”, page 40).

Possible causes	Notes
Power cable is not connected.	▶ Check the power cable and its connections.
Main switch is off.	▶ Check the (external) mains power switch. ▶ Check the main power switch on the S700. – *S710/S711:* At the rear – *S715:* In the upper enclosure part – *S720 Ex/S721 Ex:* In the analyzer enclosure
Power supply has failed.	▶ Check the power supply (for example: power socket, external fuses).
Internal power fuse is defective.	▶ Check the internal power fuses (see “Adapting to power voltage”, page 209).
Internal operating temperatures are not correct.	▶ Check whether relevant malfunction messages are displayed (“`FAULT: Temperature`...”; Display, see “Display of status/malfunction messages”, page 100; Information see “Status messages (in alphabetical order)”, page 211).
The sample gas delivery is not working correctly.	see “Sample gas connections”, page 46
The internal software is not working correctly.	Can only occur with complex internal malfunctions or after strong external influences (for example, strong electromagnetic interfering pulse). ▶ Switch off the S700. Wait for a few seconds, then switch on again.
An internal overheat protection has triggered.	Heated analyzer modules and the internal power transformer (starting from 2001) are equipped with overheat circuit breakers. These breakers are irreversible: After being blown, the circuit breaker is defective and needs to be replaced. ▶ Call the manufacturer’s Customer Service in order to replace the defective overheat circuit breaker.

▶ *If the S700 does however not start-up after you have followed these notes:* Contact the manufacturer’s Customer Service.

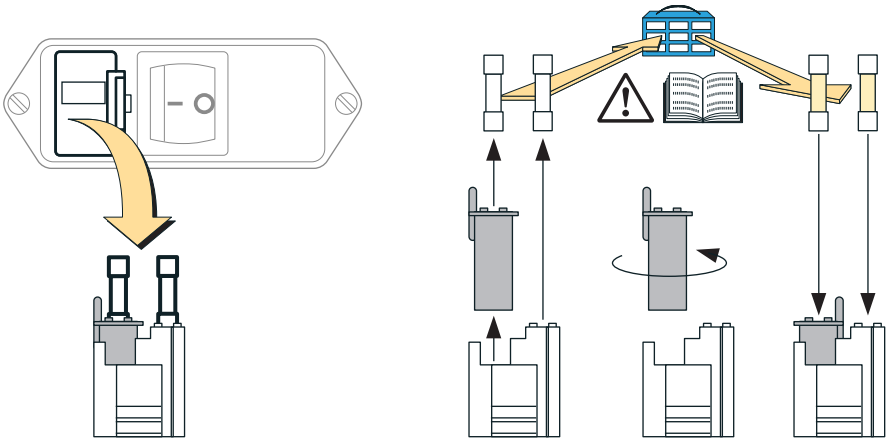
13.2 Fuses

13.2.1 Adapting to power voltage

The S700 can be set to 100 V, 115 V or 230 V power voltage. To change the setting:

1. Disconnect the S700 from the power supply.
2. Pull out the fuse box (see Fig. 33, page 209).
3. Remove the existing fuses.
4. One of the fuse holders can be removed from the fuse box. Pull out this fuse holder, turn it 90° or 180° (as required) and put it back into the fuse box. The desired power voltage should now be indicated on the front of the fuse box.
5. Insert fuses with matching specification (see “Internal fuses”, page 210) into the fuse holders.
6. Refit the fuse box.

Fig. 33: Power fuses / Changing the required power voltage



13.2.2 Internal fuses

CAUTION: Health risk
As long as the fuse box is removed, there are free electrical contacts with mains power voltage.
- ▶ *Before testing the fuses:* Disconnect the S700 from the power supply or switch the power supply off at an external point.

CAUTION: Risk of fire/severe damage
If wrong fuses are installed, a fire could possibly be started when an internal component becomes defective.
- ▶ Only use fuses as replacement which exactly meet the specified values (type of design, switch-off current, switch-off features).
- ▶ Only use fuses approved by CSA.

Table 20: Power fuses

Line voltage	Fuse(s)	Part No.
100 V	T 4A0 250V D5x20	6004310
115 V		
230 V	T 2A0 250V D5x20	6057142

Table 21: Fuses on the internal electronics board – revision 4 (latest version)

Identification	Fuse(s)	Part No.	Protects
F1	TR5-F F1A0	6021782	+24 V DC output (see “Outputs for signal voltage (auxiliary voltage)”, page 66)
F2	TR5-F F4A0	6010712	+24 V DC for relays, internal heating, internal gas pump (option)
F3	TR5-F F1A6	6026950	+5 V DC for digital electronics, IR source (UNOR, MULTOR)
F4	TR5-F F0A8	6032017	+15 V DC for analog electronics, measured value output, motors
F5			–15 V DC for analog electronics, measured value output, motors

Table 22: Fuses on the internal electronics board – revision 1/2/3 (earlier versions)

Identification	Fuse(s)	Part No.	Protects
F1	TR5-F F1A0	6021782	+24 V DC output (see “Outputs for signal voltage (auxiliary voltage)”, page 66)
F2	TR5-F F4A0	6010712	+24 V DC for relays, internal heating, internal gas pump (option)
F3	TR5-F F2A0	6028000	+5 V DC for digital electronics, IR source (UNOR, MULTOR)
F4	TR5-F F0A63 [1]	6028839	–15 V DC for analog electronics, measured value output, motors
F5			+15 V DC for analog electronics, measured value output, motors

[1] In earlier versions, F4 and F5 are equipped with F0A5 fuses. These may be replaced by F0A63 fuses.

- There are further electronic fuses with the “intrinsically safe measured value outputs” option (see “Intrinsically-safe measured value outputs”, page 74).
- Each analyzer module has its own overheat fuse (see “FAULT: temperature x”, page 211).

13.3 Status messages (in alphabetical order)

CAUTION: Damage risks, health risks
"Service information" is provided for trained service technicians only.
▶ Do not do any work inside the S700 if you are not familiar with the possible hazards.

WARNING: Health risk through dangerous gases
When the S700 has been used to measure toxic or dangerous gases:
▶ Thoroughly purge all sample gas paths with a neutral gas (for example, with nitrogen) before opening any gas paths or parts with sample gas contact.

Display message	Meaning	Cause/Notes for operator	Notes for service
`Calibration active`	A calibration procedure is running.	No malfunction message.	
`CALIBRATION ext. x` (x = 1 … 2)	A calibration is running with the measuring component which represents the measuring signal from analog input INx (see "Analog inputs", page 69).		
`CALIBRATION sensor x` (x = 1 … 3)	Calibration is running with analyzer module x.	Coding of x, see "Display of device data", page 102	
`CHECK STATUS/ FAULTS`	Several status and/or malfunction message exist at the present time.	▶ Call up the list of status/malfunction messages (see "Display of status/ malfunction messages", page 100)	
`FAILURE extern x` (x = 1 … 2)	Control input "failure x" is activated.	Indicates a fault signal from an external device (see "Available control functions", page 122). Not a malfunction in the S700.	If control logic is reversed, this message will also occur when the electrical connection is interrupted. *Information:* This message is not related in any way to the status output "FAILURE extern x" (see "Available switching functions", page 121).
`FAILURE sensor x` (x = 1 … 3)	Analyzer module x is not fully operational. (Coding of x, see "Display of device data", page 102).	Possible causes: – The internal temperature is not in the nominal range of the heating control. – The zero point drift or sensitivity drift exceeds 120% of the drift limit value set (see page 160). – The measuring signal of the analyzer module is not in the operational range. – UNOR/MULTOR: The analyzer module is defective.	Possible defect for UNOR/MULTOR: The chopper disk (chopper) does not rotate correctly.
`FAILURE Sensor ext.x` (x = 1 … 2)	The measured value which represents the internally processed measuring signal from analog input INx (see "Analog inputs", page 69) is probably wrong.	The zero drift or sensitivity drift of the measuring signal exceeds 120% of the drift limit value set (see page 160).	
`FAULT: Cal. cuvette`	After a calibration with calibration cuvette, the sensitivity drift is significantly higher than the drift limit value set (over 120% of the drift limit value).	Possible causes: – No zero gas was fed while the calibration cuvette was active (for example, gas feed did not work correctly). – The nominal values of the calibration cuvette are no longer correct (see "Calibration of the calibration cuvette (option)", page 173). – The calibration cuvette did not work correctly (see service information).	Possible defects: – Drive mechanism defective – Motor defective – Electrical connection defective – Gas filling of the calibration cuvette defective
`FAULT: chopper`	Rotation signal from the chopper in the UNOR or MULTOR module is missing.	The S700 is defective. ▶ Contact the manufacturer's Customer Service.	▶ Electrical connection? ▶ Chopper loose or stuck? ▶ Defective motor? ▶ Defective photoelectric barrier? ▶ Defective chopper motor control?

Display message	Meaning	Cause/Notes for operator	Notes for service
`FAULT: compensation`	The temperature sensor used for the temperature compensation of the modules does not work.	*Electronic board as from revision 5:* Jumper on position X25 is missing.	▸ Set a jumper so that the middle and right pins of X25 are bridged (seen from the front). The pins are not labeled.
		The temperature sensor is defective.	The temperature sensor is part of the electronic board (can not be replaced individually). ▸ Replace the complete electronic board.
`FAULT: condensate`	Condensate is present in the internal sample gas path of the S700. – This message triggers automatic deactivation of the gas pump and switching output “external pump” (when active).	The S700 must be serviced. ▸ Put the S700 out of operation. ▸ Contact the manufacturer’s Customer Service or trained skilled persons. *After servicing:* ▸ Switch malfunction message off per menu (see “Acknowledging alarms”, page 105).	1. Check/service external sample gas conditioning. 2. Service S700: ▸ Separate analyzer modules from internal sample gas path to prevent condensate penetrating. ▸ Corrosive condensate, electrically conductive residues → remove condensate sensor, rinse with demineralized water and dry. ▸ Purge the condensate sensor and the internal sample gas paths (incl. pump) with dry air. ▸ Check internal safety filter (glass); replace if necessary. ▸ *When condensate could have entered the analyzer module:* Service/replace the module.
`FAULT: controller 4`	(The actual value of controller 4 is outside the nominal range.)	–	Reserved for future use.
`FAULT: filter wheel`	Rotation signal from filter wheel of the MULTOR module missing.	▸ Switch the S700 off and on again. ▸ *If this does not help:* Inform the manufacturer's Customer Service – the S700 is defective.	– Electrical connection? – Filter wheel loose or stuck? – Defective photoelectric barrier? – Step motor defective? – Control of the step motor defective?
`FAULT: flow signal`	The signal from the flow sensor has exceeded the operating range of the internal analog/digital converter.	▸ *If the message remains displayed for a longer time (several seconds):* Switch the S700 off and on again. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	▸ Try disconnecting the sensor cable from the electronics board. ▸ *If the malfunction message has disappeared:* Check cable and sensor.
`FAULT: gas flow`	The gas flow in the sample gas path of the S700 is lower than 50% of the programmed limit value (see “Setting the flow monitor limit value”, page 137).	▸ *During measuring operation:* Check sample gas feed (filter, valves, lines, etc.) ▸ *During a calibration:* Check calibration gas feed (gas cylinders, setting of the pressure reducer, valves, etc.).	Only appears for devices with option “flow monitor”. In the range from 50 ... 100% of the limit value `SERVICE: gas flow` appears instead.
`FAULT: int. voltage`	At least one internal supply voltage is not OK (outside the nominal range).	▸ Switch the S700 off and on again. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	▸ Check the internal supply voltage (see “Internal supply voltages”, page 140) and internal fuses (see “Internal fuses”, page 210). ▸ *If no fault detectable:* Replace electronic board as test.
`FAULT: IR source`	Infrared heater of the analyzer module UNOR or MULTOR is defective or interrupted.	The S700 is defective. ▸ Contact manufacturer’s Customer Service or trained skilled persons.	▸ Check heater voltage (see “Signals of the internal sensors and analog inputs”, page 139): – Too high? Cable defective? Heater severely damaged or unusable? – Too low? Short circuit? Electronics defective? Heater defective? Fuse defective (see “Internal fuses”, page 210)? (Setting of the nominal voltage is part of the “factory setting”; perform a basic calibration after changes.)

Display message	Meaning	Cause/Notes for operator	Notes for service
FAULT: overrange x (x = 1 … 5)	Measured value of measuring component x is higher than 120% of the physical measuring range end value. *Attention:* The displayed measured value does probably not represent the real concentration of the measuring component.	▸ Check whether the concentration of the measuring component could actually be this high now. ▸ *If this is the case:* Contact the manufacturer's Customer Service or trained skilled persons.	Clearance not possible by changing settings. ▸ *When measured value should be within measuring range:* Disconnect electrical connection of the affected analyzer module. ▸ *When the error message has disappeared:* Service/replace the module.
FAULT: pressure signal	Signal from the pressure sensor exceeds the working range of the internal analog-to-digital converter.	▸ *If the message remains displayed for a longer time (several seconds):* Switch the S700 off and on again. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	▸ Separate pressure sensor from electronic board as test (plug connector X21). Put the S700 back into operation. ▸ *If the malfunction message has disappeared:* Replace sensor.
FAULT: S-drift #x (x = 1 … 5)	The sensitivity drift is significantly greater than the set drift limit value for measuring component x (over 120% of the limit value).	Possible causes: – Test gas was not available (check gas cylinders). – Gas feed does not work correctly (check gas lines, valve function, gas flow). – The set nominal value does not match the test gas concentration (see “Test gases for sensitivity calibration”, page 150). – Message SERVICE: S-drift was ignored even though the deviation from basic state is very large. – Special notes exist for O2 (see “Replacing the O_2 sensor in the OXOR-E module”, page 205). ▸ Eliminate the cause. ▸ Then run a calibration.	▸ Check the settings for test gas delay time and calibration measuring interval (see page 161 and Page 162). ▸ Check the drift limit values (see “Setting the drift limit values”, page 160). ▸ If this fault appears often during operation for UNOR or MULTOR components, increase the respective drift limit values (especially applies to low measuring ranges). ▸ Thoroughly check test gases and gas lines. ▸ Then run a calibration and check the drift values (see “Display of drift values”, page 103). *If drift values are still too high:* ▸ Clean/adjust the analyzer module. ▸ Then perform a basic calibration.
FAULT: Signal #x (x = 1 … 5)	Measuring signal for measuring component x cannot be processed internally.	▸ Switch the S700 off and on again. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	▸ (Signal has exceeded the value range of the internal analog-to-digital transducer.) Try disconnecting the electrical connection to the analyzer module.
FAULT: temperature x (x = 1 … 3)	Temperature of analyzer module x is not within the operating range.	Possible causes: ▸ Ambient temperature is either too high or too low ▸ The internal heating is not working ▸ The S700 was previously switched off for a short time When this message appears after a short operating break of the S700, the error message will disappear after a few minutes. In all other cases: ▸ Check ambient temperature. Note: When the S700 is fitted in an outer enclosure (or for example a cabinet), check the temperature in the outer enclosure, not the outdoor temperature. ▸ If necessary, take suitable measures to correct the ambient temperature. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	Possible defects: – Electrical fuse (see “Internal fuses”, page 210) – Temperature sensor in the analyzer module – Electrical connections in heating circuit – Heating electronics defective – Overheat fuse in the analyzer module (breaks at approx. 80 °C). Chemical fusible cutout; must be replaced after triggering.

Display message	Meaning	Cause/Notes for operator	Notes for service
FAULT: test gas x (x = 3 … 6)	Control input “Test gas x fault” was activated during calibration.	Only applicable when such a control input is installed (see “Available control functions”, page 122). ► Check whether a corresponding external malfunction exists (for example, gas cylinder is empty). ► *When malfunction cleared:* Repeat calibration.	Further possible causes: – Electrical connection defective – External monitoring device defective
	At least one measured actual value deviated strongly from the nominal value (calculated drift exceeded 200% of set drift limit value) when feeding the specified calibration gas during the last automatic calibration.	Possible causes: – The calibration gas was not available (check pressure cylinder). – Gas feed did not work correctly (check gas lines, valve functions and gas flow). – Set nominal value does not match gas used (see “Setting the nominal values for the calibration gases”, page 159). – Set nominal value does not meet the physical requirements (see “Zero gases (calibration gases for the zero point)”, page 149). ► Check the drifts to find out which measuring component causes the problem (see “Display of drift values”, page 103). ► Eliminate the cause. ► Then run a calibration again (automatic or manual).	► Check calibration gases. ► Check gas lines. ► Check the settings for test gas delay time and calibration measuring interval (see page 161 and Page 162). ► Check the drift limit values (see “Setting the drift limit values”, page 160). ► Possibly perform a manual calibration procedure to observe the process exactly.
FAULT: Z-Drift #x (x = 1 … 5)	The zero point drift is significantly greater than the set drift limit value for measuring component x (over 120% of the limit value).	→ Fault S-Drift X	→ Fault S-Drift X
FAULT Zero gas x (x = 1 … 2)	→ Fault Test gas x	→ Fault Test gas X	→ Fault Test gas X
Heating … x (x = 1 … 3)	The S700 has not yet reached its operating temperature after power-on (x = internal heating circuit).	Not a fault. These messages will disappear within 30 minutes after power-on. ► Do not perform any binding measurements or any calibrations as long as these kind of messages are displayed.	This message does not disappear when the S700 does not reach the relevant nominal temperature. Possible causes: Ambient temperature too low, internal heating defective.
INTERRUPT ext. x (x = 1 … 2)	Control input “Fault x” is activated.	Indicates a fault signal from an external device (see “Available control functions”, page 122). Not a malfunction in the S700.	If control logic is reversed, this message will also occur when the electrical connection is interrupted.
Maintenance/ calibration	Status output “Service” activated manually.	see “Activating the maintenance signal”, page 107	
	A calibration procedure is running.	Remains after the test gas feed has finished until a test gas delay time has elapsed.	
	A function of menu branch 7 (Service) has been called.	Some of these menus will interrupt the S700 measuring function. Therefore usage of these menu branches automatically activates the maintenance signal.	
No reports !	There are no status or malfunction messages at this time.	Only appears in the list of status/ malfunction messages (see “Display of status/malfunction messages”, page 100).	
PC control active !	External PC controls the S700	see “Remote control with “AK protocol””, page 182.	
SERVICE extern x (x = 1 … 2)	Control input “Service x” is activated.	Indicates a fault signal from an external device (see “Available control functions”, page 122). Not a malfunction in the S700.	If control logic is reversed, this message will also occur when the electrical connection is interrupted.

Display message	Meaning	Cause/Notes for operator	Notes for service
SERVICE: gas flow	The volume flow in the sample gas path of the S700 is somewhat lower than the set limit value of the flow monitor (see page 137).	▸ *During measuring operation:* Check sample gas feed (filter, valves, lines, etc.) ▸ *During a calibration:* Check calibration gas feed (gas cylinders, setting of the pressure reducer, valves, etc.).	Only appears for devices with option “flow monitor”. When the flow is lower than 50% of the limit value, FAULT: flow is displayed.
SERVICE: Sensor x (x = 1 … 3)	The measured values originating from analyzer module x may be wrong (i.e. do not match the real concentration).	▸ Check whether the real concentration of the measuring components could actually be very high at the moment. ▸ *If this is the case:* Contact the manufacturer's Customer Service or trained skilled persons.	Criterion for message: Current measuring signal of analyzer module x is higher than 120% of the programmed A/D transducer dynamic range.
SERVICE: Sensor ext.x (x = 1 … 2)	The measured value which represents the internally processed measuring signal from analog input INx (see “Analog inputs”, page 69) will be processed with a larger drift compensation.	Zero point drift or sensitivity drift of the measuring signal is 100 … 120% of the set drift limit value (see page 160).	
SERVICE: S-Drift #x (x = 1 … 5)	The drift determined for measuring component x during the last calibration is above the set drift limit value.	Measuring function of the S700 is not yet restricted.	When the drift is higher than 120% of the set drift limit value (see page 160), FAULT: …-Drift x is reported.

13.4 If the measured value is obviously incorrect ...

Possible causes	Notes	Notes for service
The S700 is not ready for operation.	– Commissioning see page 77 – Display of status/malfunction messages see page 100	–
The S700 is not measuring the sample gas. The sample gas path is not activated correctly.	▸ Check the sample gas path and all valves (for example, switching from test gas to sample gas).	▸ Make sure that the valves are functioning correctly, disassemble if necessary.
The S700 is not correctly calibrated.	▸ Check requirements for correct calibration: – Correct gases used? (see “Calibration gases”, page 148) – Nominal values set correctly? (see “Setting the nominal values for the calibration gases”, page 159) ▸ Then run a calibration.	▸ Carefully check the test gases used (nominal values, manufacturing tolerances, state, age).
The “damping” value is set too high for the application.	▸ Check setting (see “Setting damping (rolling average value computation)”, page 111); possibly change as test.	–
The sample gas pressure inside the S700 is too high.	▸ Ensure the sample gas pressure is in an allowable range (see “”, page 243).	The gas pressure can influence the measured values in most of the measuring principles used.
The sample gas path is not gas-tight.	▸ Visually inspect the installation. ▸ *When a defect is suspected:* Inform the manufacturer's Customer Service or trained skilled persons.	Leak tightness check, see page 201.
When only observed on one measured value output: The load is too high.	▸ Make sure the total internal resistance of the connected devices is not larger than 500 Ω.	▸ Measure including the connecting line.
The analyzer module is dirty.	▸ Contact manufacturer’s Customer Service or trained skilled persons.	▸ Inspect the measuring cell/ cuvette. ▸ Clean or replace if necessary.
With option “external cross-sensitivity compensation”: Fed analog signal is erroneous.	▸ Check the external equipment providing the analog signal for cross-sensitivity compensation.	– Connection interrupted? – Problem with the external measurement? – External analyzer not calibrated?

13.5 If measured values are unstable for no apparent reason ...

Possible causes	Notes	Notes for service
High pressure fluctuations on the sample gas outlet.	▸ Install a separate vent line for the S700.	–
Strong mechanical vibrations.	▸ Check the ambient conditions where the S700 is installed.	–

14 Shutdown procedure

14.1 Shutdown procedure

A) Securing connected devices/systems

- The shutdown of the analyzer could affect external systems. It may be necessary to consider which switching logic is used for the switching outputs of the gas analyzer (see “Control logic”, page 120).
- If a data processing system is connected, it may be required to manually indicate a planned shutdown, so that the system will not interpret the shutdown as an analyzer malfunction.

▶ If required, inform the operators of connected equipment that you are planning a shutdown.
▶ Check if any automatic emergency measures could be triggered when you shutdown the analyzer.

B) Removing the sample gas completely

1. Stop the gas feed to the S700 .
2 Disconnect the S700 from external sample gas paths so that no sample gas can flow into the S700.
3 Purge all gas paths in the S700 for several minutes with a “dry” neutral gas – for example, with technical grade nitrogen or with a zero gas. It is recommended to include the peripheral gas paths in this purging operation.
4 Then close-off all S700 gas connections or close the related valves in the purged gas line.

WARNING: Health risk through dangerous gases
When the S700 has been used to measure toxic or dangerous gases:
▶ Thoroughly purge all sample gas paths with a neutral gas (for example, with nitrogen) before opening any gas paths or parts with sample gas contact.

NOTE:
Gas analyzers heat the internal sample gas system to create constant internal temperatures (analyzer modules of the S700: approx. 50 °C). A side-effect is that condensation would not occur in the internal measuring system.
However, when the gas analyzer is taken out of operation, the internal temperature falls, and now condensation could occur inside the measuring system. This must be avoided because this can damage the measuring system or make it unusable.
The consequence is:
▶ Always purge the internal sample gas path thoroughly with a “dry” neutral gas before each shutdown task.

C) Switch off power

▶ *S710/S711:* Switch off the main power switch on the rear of the enclosure (see Fig. 14, page 62) or disconnect the main power supply at an external location (external switch, fuse).
▶ *S715/S720 Ex/S721 Ex:* Disconnect the main power supply at an external location (external switch, fuse).
▶ S715: Before opening the enclosure, observe the safety instructions before opening the enclosure (see “Safety precautions before opening the enclosure”, page 55)

D) Store properly

▶ See Correct storage”, (see page 220).

14.2 Disposal information

These subassemblies could contain materials which may require special disposal:

- *Electronics:* Electrolyte capacitors, tantalum capacitors
- *Display:* Liquid of the Liquid Crystal Display (LCD)
- *Sample gas paths:* Toxic materials in the sample gas could have been absorbed or trapped in the “soft” gas path material (for example, hoses, sealing rings). Check if special procedures are required for the disposal of such components.
- *Analyzer modules* UNOR *and* MULTOR: For some applications, the measuring chamber (IR sensor) and the reference side of the cuvette are filled with a gas or gas mixture similar to the sample gas. Check if these could be toxic or dangerous gases; if in doubt, always ask the manufacturer before opening or destroying components.

WARNING: Health risk through dangerous gases
When the S700 has been used to measure toxic or dangerous gases:
▶ Thoroughly purge all sample gas paths with a neutral gas (for example, with nitrogen) before opening any gas paths or parts with sample gas contact.

14.2.1 Disposal of batteries

NOTE:
Batteries must not be disposed of with household waste.
Observe the applicable local regulations for disposal.

14.2.2 Removing the battery

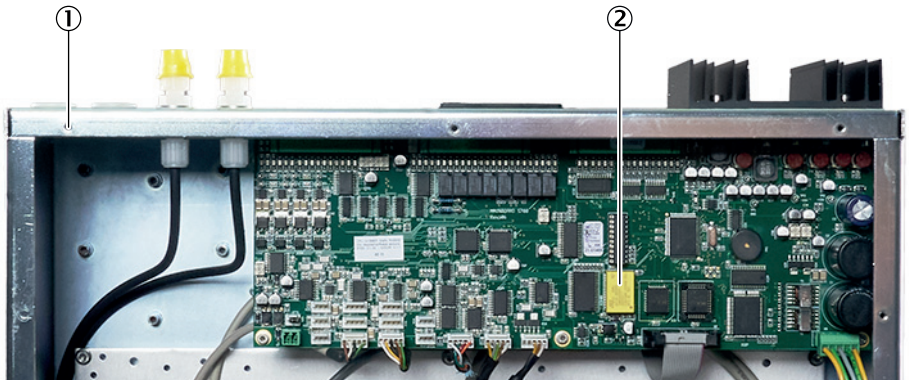
WARNING: Hazardous gases in the enclosure
If there is a leak in the internal gas path, hazardous gases may have collected:
- For S715/S720 Ex/S721 Ex in the enclosure.
- For S710/S711 in a possibly existing outer enclosure.

▶ Observe the instructions in Section 4.8 “Opening and closing the enclosure” of the Operating Instructions.

S710/S711

1. Dismantle the device:
   ▶ Put the device out of operation.
   ▶ Disconnect the power plug.
   ▶ Disconnect the signal lines.
   ▶ Unscrew the gas lines.
   ▶ Remove the device.
2. Remove the enclosure cover:
   ▶ Unscrew the 10 screws ① of the enclosure cover.

3 Use a small screwdriver to lever out battery ② on the mainboard.



S715/S720 Ex/S721 Ex

1. Dismantling the device: See Operating Instructions S700, Section 4.8
2 Remove batteries: See step 3 above.

15 Storage, transport

15.1 Correct storage

- *When the S700 has been separated from gas lines:* Close off the S700 gas connections (with sealing plugs, if necessary with adhesive tape) to protect against moisture, dust or dirt penetrating the internal gas path.
- Cover the electrical connectors (dust-tight), for example with adhesive tape.
- Protect the keypad and display against sharp-edged objects. If necessary, cover the device with a protective material (for example: cardboard, Styrofoam).
- Select a dry and well-ventilated room for storage.
- Pack the device (for example, in a plastic bag).
- *When high air humidity can be expected:* Include a drying agent (SilicaGel) in the packing.
- *When the S700 is fitted with the OXOR-E Analyzer module:* Keep gas connections gas-tight during storage.

The service life of the O_2 sensor in the OXOR-E module is significantly shortened by contact with oxygen from the air, even when the S700 is switched off.

15.2 Correct transport

CAUTION: Risk of injuries and accidents
- Observe the safety information on transport (see “Safety notes on transport”, page 39)

- *Protective measures:* As described in „Correct storage“.
- *Packing:*
  - Use a strong container completely padded on the inside.
  - Make sure there is sufficient space between the analyzer and the walls of the container.
  - Fasten the analyzer securely in the container.
- *Documents shipped with the analyzer:* see “Shipping for repair”.

15.3 Shipping for repair

All information on repair flat rates, Repair form (incl. Non-Risk Declaration and return information) can be downloaded at https://www.de.endress.com/de/download.

NOTE:
Without the Non-Risk Declaration, the device will either be cleaned at the customer's expense or the package not accepted.

Procedure:

- Contact your local Endress+Hauser representative. Addresses: See back of the Operating Instructions.
- Clean the device.
- Fill in the Repair form including Non-Risk Declaration and send in advance to the Endress+Hauser representative by e-mail.
- Pack the device carefully and shockproof in the original packaging for transport.
- Enclose Repair form and attach to the outside of the package.

15.3.1 Cleaning the device before returning

Prerequisite: Device must be disconnected from the power supply.

NOTE:

- Close the enclosure before cleaning so that no fluid can penetrate.
- Do not use high-pressure cleaners, mechanical or chemically aggressive cleaning agents.

Clean surfaces and parts with media contact:

- Remove loose contamination with compressed air.
- Remove adhering contamination with a mild soap solution and a soft cloth.
- Do *not* clean optical surfaces.

16 Special notes

16.1 Special version “THERMOR 3K”

Only applies for S700 with THERMOR 3K analyzer module .

16.1.1 Purpose of the “THERMOR 3K” special version

Turbo-driven power generators can be filled with hydrogen, to achieve a better cooling. However, the gas filling must be monitored during operation and during replacement procedures because of these reasons:

- For maintenance work, the gas filling must temporarily be replaced by air. Because hydrogen + air would be an explosive mixture, the hydrogen is first replaced with CO_2, then the CO_2 replaced by air. Refilling with hydrogen works vice-versa. These filling procedures need to be monitored.
- During operation, it must be guaranteed that no air has penetrated into the gas filling.

For these tasks, there is the special version “THERMOR 3K” of the S700. This special version uses a single THERMOR type analyzer module and a special method for measuring signal processing. This enables the following measurements:

Table 23: Measuring components of the special version for turbo-generators

Name of meas. component	Meas. value output	Output range		
H2-CO2	OUT1	0 ... 100 vol.%	H_2	in CO_2
CO2-Air	OUT2	0 ... 100 vol.%	CO_2	in air
H2-Air	OUT3	80 ... 100 vol.%	H_2	in air

16.1.2 Special features of the special version “THERMOR 3K”

Selecting the correct measuring component

Due to the special measuring methods, only the measured values of the “measuring component” relevant in the current operational or filling phase are correct. The measured values of both the other “measuring components” are not valid (negative/non-calibrated values).

Therefore, you must determine in which operational or filling phase the turbogenerator currently is, and then activate the large measuring display for the related single measuring component (see “Large display for one selected component”, page 98). This selection deactivates the measured value outputs of the other measuring components: These output “0 vol.%”.

For THERMOR 3K, the combined display for all measuring components (see “Combined display for all components”, page 97) is *not* suitable for measuring operation.

Remote selection control

- For remote control of a single measuring component, the control inputs can be used with function “MBU output x”; see “Available control functions”, page 122. x corresponds to the associated measured value output (see Fig. 23, page 222).
- The selected measuring component (i.e. the active measured value output) can be indicated by status outputs; see “Available switching functions”, page 121.

Special menu features

As long as the large measuring display for a single measuring component is activated, all menus will be restricted to this measuring component (except for the `measuring display` menu). The combined display for all measuring components must be activated when the menu system should include all the measuring components; see “Combined display for all components”, page 97.

Measured value outputs

- The measuring components are assigned to certain measured value outputs (see Fig. 23, page 222). This setting cannot be changed; see “Assigning measuring components”, page 116.
- The measured value outputs have only one output range (see “Selecting the output ranges”, page 118). These output ranges cannot be changed see “Setting-up the output ranges”, page 117.
- As long as the large measuring display for one measuring component is selected, only the associated measured value output is active; the other measured value outputs constantly display “0 vol.%”.

Calibration

Observe the special information on calibration and basic calibration; see “Calibrating the special version THERMOR 3K”, page 180.

Firmware update

The special functions for THERMOR 3K are included in the standard software. For a firmware update, the standard software for the S700 series can be used (see “Firmware update”, page 136).

16.2 Automatic compensations

CAUTION: Risk of incorrect measurements
▶ *When the S700 is working with a cross-sensitivity or carrier gas composition:* Observe the information in this Section.
Otherwise incorrect measured values could be produced.

16.2.1 Information on active compensations

Information in the documents delivered with the device

▶ Check whether a compensation for certain measuring components is specified in the documents delivered with the S700.

Check whether your S700 measures both NO and SO_2 with one MULTOR module (see delivered information or print of the software configuration, line “sensor type”).
If this applies, then this MULTOR module usually also measures the H_2O concentration and performs an H_2O cross-sensitivity compensation for SO_2 and NO – even if this feature is not specified in the information delivered with the analyzer.

Information in the analyzer

To obtain all information on activated compensations:

▶ Use the `print config.` function to print or transmit a part of the internal device data (see “Printing the internal configuration”, page 127).

These are the data involved (example):

```
Meas. components  :         SO2          CO         CO2          O2    Temp. C
Meas. compensation:           3           3           3           3           3
a                 : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
b                 : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
c                 : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
d                 : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
e                 : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
f                 : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
SO2               :        OFF          No         OFF         OFF         OFF
CO                :        Yes         OFF          No         OFF         OFF
CO2               :        OFF         OFF         OFF          No         OFF
O2                :        OFF         OFF         OFF         OFF         OFF
Temp. C           :        OFF         OFF          No         OFF         OFF
```

- The `Meas. component` lines show all S700 measuring components and in addition the temperature which can also be compensated.
- The code in the `Meas. compensation` line specifies the automatic compensation or mathematical calculation active for the measuring component (explanation and consequences, see Fig. 24, page 225).
- Lines `a` … `f` display the factory-set mathematical parameters used for measured value processing.
- The `yes/no/OFF` information specifies whether a cross-sensitivity effect was found for the respective measuring component during the manufacturing process:

`OFF`	A cross-sensitivity effect was not found – which means a cross-sensitivity compensation is not required for this pair
`yes`	A cross-sensitivity effect was found and an automatic cross-sensitivity compensation was activated.
`no`	A cross-sensitivity effect was found but an automatic cross-sensitivity compensation was not activated.

16.2.2 Consequences of automatic compensations

During calibrations, the automatic compensations are *out of operation*. The following Table shows the available compensations and their consequences:

Table 24: Consequences of automatic compensations

Code	Automatic compensation or relation	Consequences ...	
		... for measurement	... for calibration
0	None	None	None
1	External cross-sensitivity compensation for measuring component A with measured value X from analog input IN1 (see “Analog inputs”, page 69)	Measured values A and X must be synchronous. *Example:* When the external measured value represents a gas component, then the sample gas must synchronously flow through the external gas analyzer and the response times of the external gas analyzer and the S700 must correspond.	Calibration gases used for measuring component A must not contain the measuring component X. *Note:* The setting for “calibration with cross-compensation” (see “Calibration of cross-sensitivity compensations (option)”, page 177) has no influence.
2	As code 1, however with measured value from analog input IN2		
3	Cross-sensitivity compensation for measuring component A with internal meas. component X	– *When X is an internal measured value:* None – *When X represents a fed external measured value:* See notes for codes 1 and 2.	Zero gas used for measuring component A must not contain measuring component X.
4	Mathematical cross-calculation of internal measured values A and X	This option creates a “virtual” measuring component V which is displayed the same as a real measuring component.	Measuring component V cannot be directly calibrated. The measured values of V are correctly calibrated when measuring components A and X are correctly calibrated.
5	Carrier gas compensation for meas. component A with the internal measuring component X	None	Zero gas and test gases used for measuring component A must not contain measuring component X.
	Carrier gas compensation + cross-sensitivity compensation for meas. component A with the internal measuring component X	– *When X is an internal measured value:* None – *When X represents a fed external measured value:* See notes for codes 1 and 2.	

16.3 Notes on particular measuring components

16.3.1 Measuring component CO

Interfering effects: When an unsuitable NO_X converter is installed in the sample gas path, CO_2 can partly or totally be converted to CO. Thus wrong measured values would be produced for CO, although the gas analyzer is working correctly.

Remedy: Use a suitable NO_X converter (see “Disturbing effects with NO_X converters”, page 230).

16.3.2 Measuring component CO_2

NO_X converter

Interfering effects: When a NO_X converter is installed in the sample gas path, CO_2 can under certain circumstances be partly or totally converted to CO. Thus, wrong CO_2 measured values would be produced, although the gas analyzer is measuring correctly.

Remedy: Use a suitable NO_X converter (see “Disturbing effects with NO_X converters”, page 230).

Sample gas cooler

Interfering effects: When a sample gas cooler is used, some of the CO_2 could be dissolved in the condensate and thus be removed from the sample gas path. Thus, wrong CO_2 measured values would be produced, although the gas analyzer is measuring correctly.

Remedy: Install a condensate acidification (see “Disturbing effects with a sample gas cooler”, page 228).

16.3.3 Measuring component H_2O

Plastic gas lines

Interfering effects: Many plastic materials are permeable for gaseous H_2O. This means that in plastic gas lines a portion of the H_2O concentration could be lost or additional H_2O could enter the sample gas. This would cause wrong measured values although the gas analyzer is working correctly. This effect is particularly strong with PTFE.

Remedy: Use metal gas lines.

Sample gas cooler

Interfering effects: When a sample gas cooler is used, wrong measured values can occur when measurements and calibrations are performed in the wrong way.

Remedy: Observe the information in Disturbing effects with a sample gas cooler”, (see page 228) and Calibrations with a sample gas cooler”, (see page 229).

16.3.4 Measuring component O_2

Interfering effects: When the S700 measures the O_2 concentration with the analyzer module OXOR-P, the O_2 measured value can be falsified when the sample gas contains other gas components which have a high paramagnetic or diamagnetic susceptibility.

Remedy: Observe the information in Cross-sensitivity compensation with OXOR-P”, (see page 179).

16.3.5 Measuring component SO_2

H_2O cross-sensitivity

In the NDIR analysis of SO_2, an H_2O cross-sensitivity cannot be avoided due to strong overlapping of the absorption ranges. Thus the SO_2 analysis is generally “sensitive” against the H_2O concentration. In many cases this effect is so small that it does not reduce the specified measuring precision. In some cases, however, it is required to use H_2O cross-sensitivity compensation in order to maintain the specified measuring precision.

Sample gas cooler

Interfering effect: When a sample gas cooler is used, some of the SO_2 could be dissolved in the condensate and thus removed from the sample gas path. This would cause wrong SO_2 measured values, although the gas analyzer is working correctly.

Remedy: Install a condensate acidification (see “Disturbing effects with a sample gas cooler”, page 228).

Analysis of both SO_2 and NO in one MULTOR module

If the S700 measures both the SO_2 and NO concentration with a MULTOR module (see delivered information or “Information on active compensations”, page 224), then this MULTOR module usually also measures the H_2O concentration and performs an H_2O cross-sensitivity compensation for SO_2 and NO – even if this feature is not specified in the information delivered with the analyzer.

Measure: In this case, observe information in Calibration of cross-sensitivity compensations (option)”, (see page 177).

Analysis of SO_2 and NO in separate analyzer modules

If the S700 should measure both the SO_2 and NO concentration and a high sensitivity is required, then SO_2 and NO are measured in two separate analyzer modules (UNOR/UNOR or UNOR/MULTOR). In this case, an internal H_2O cross-sensitivity compensation is not possible.

Measures: Observe the information in Calibrating H_2O cross-sensitivity measuring components”, (see page 179).

16.3.6 Measuring component NO / NO_X

H_2O cross-sensitivity

As for SO_2, the NDIR gas analysis of NO cannot avoid an H_2O cross-sensitivity, due to strong overlapping of the absorption ranges. The NO analysis is therefore generally “sensitive” against the H_2O concentration – as long as no H_2O cross-sensitivity compensation is active. Please observe the following notes:

Analysis of both NO and SO_2 in one MULTOR module

see “Measuring component SO_2”

Analysis of NO and SO_2 in separate analyzer modules

see “Measuring component SO_2”

NO_X converter

see “Disturbing effects with NO_X converters”, page 230

16.4 Information on using a sample gas cooler

16.4.1 Purpose of a sample gas cooler

No condensation may occur in the internal gas paths of a gas analyzer. Condensation can occur when the sample gas temperature at the sampling point is higher than in the gas analyzer and the sample gas contains condensable gas components – for example, H_2O in the exhaust gas of a combustion plant.

In such cases, the temperature of the sample gas must be lowered once, prior to feeding into the analyzer, in order to lower the dew point (= the temperature where condensation occurs). Usually, a sample gas cooler is used here where the temperature of the flowing sample gas is significantly decreased; this removes most of the condensable components from the gas.

However, the condensable components will not be removed completely. It may be necessary to consider this fact in some applications in order to obtain correct measured values (see “Disturbing effects with a sample gas cooler”). For H_2O, the remaining concentration is approximately 7000 … 11000 ppm, depending on the cooler temperature (see Table 15, page 176).

16.4.2 Disturbing effects with a sample gas cooler

Interfering effects during “H_2O sensitive measurements

If the S700 measures at least one measuring component which has a cross-sensitivity against H_2O and an automatic H_2O cross-sensitivity compensation is *not* active, then the measured values can be affected by physical changes in the sample gas cooler.

Remedy: Ensure a constant state of the sample gas cooler.

Interfering effect with water-soluble gases (for example, CO_2, SO_2)

Inside the sample gas cooler, there is a relatively large surface of condensed water. This has consequences for gases with high physical or chemical high solubility in water (for example, CO_2, SO_2): Such gas components can dissolve in the sample gas cooler as condensate and thus removed from the sample gas. This means the measured value would be smaller – although the gas analyzer is working correctly. The lower the real gas concentration is, the greater the relative measuring error. This could also affect the calibration when the calibration gases flow through the sample gas cooler (see “Calibrations with a sample gas cooler”, page 229).

Remedy: If the dissolved gas creates an acid with water, minimize the interfering effect by acidifying the condensate in the sample gas cooler with this acid and keeping the pH level in the sample gas cooler permanently below pH 2. In this way, the condensate will be “saturated” and will not absorb the respective gas. To do this, feed the respective acid (for example, H_2CO_3, H_2SO_3) into the gas path of the sample gas cooler. Please note the sample gas cooler needs to be corrosion-resistant.

Disturbing effect due to drying-out in the course of long calibration procedures

Calibration gases from gas cylinders are usually “dry”, which means they practically do not contain H_2O. When such calibration gases are flowing through the sample gas cooler for a certain time, the cooler could dry out. This extreme change of state can cause an incorrect calibration – especially for “H_2O-sensitive” measuring components.

Remedy: Produce “wet” calibration gas. To do this, install a suitable vessel in the gas path, filled with water, and let the calibration gases bubble through the vessel before being fed into the sample gas cooler.

16.4.3 Calibrations with a sample gas cooler

Correct calibrations with "internal H_2O cross-sensitivity compensation"

When the S700 is working with an "internal H_2O cross-sensitivity compensation" option, then all of the calibration gases should flow through the sample gas cooler before being fed into the gas analyzer (exemplary flow schedule see Fig. 8, page 46).

The only exceptions to this rule apply to:

- Zero point calibration of the measuring component H_2O (see "Calibration of measuring component H_2O", page 174)
- Calibration of the cross-sensitivity compensations (see "Calibration of cross-sensitivity compensations (option)", page 177).

Consequences of "moist" calibration gases

For this method, let the calibration gases flow through the sample gas cooler – in the same way as the sample gas before they reach the gas analyzer.

Thus, the calibration gases are changed in the same way as the sample gas in the sample gas cooler. Advantage: The actual influence of the sample gas cooler is recorded physically and considered in the calibration; the influence on H_2O cross-sensitivity effects (if existing) is also considered physically in this way.

However, there are some disadvantages with this method:

- Because the physical conditions in the sample gas cooler are not exactly constant, the results of several calibrations might not be exactly identical. This means you can not evaluate the gas analyzer drift by direct comparison of individual calibrations against each other.
- Because calibration gases from gas cylinders practically do not contain any H_2O, the sample gas cooler could dry out in the course of a long calibration procedure. This would neutralize the advantage of this method (remedy, see "Disturbing effects with a sample gas cooler", page 228).

Consequences of "dry" calibration gases

If the calibration gases are fed directly into the gas analyzer without being led through the sample gas cooler, the single calibration results can be reproduced. This allows, for example, monitoring gas analyzer drift.

Disadvantage of this method: The calibrations do not consider the influence of the sample gas cooler. It may be necessary to quantify the influence of the sample gas cooler. Perform measurements using calibration gases instead of the sample gas. Feed the calibration gases in once directly (the same way as for calibration) and once through the sample gas cooler (the same way as the sample gas). Consider the differences in measuring operation. It might be advisable to repeat these reference measurements from time to time.

16.5 Information on using a NO_X converter

16.5.1 Purpose of NO_X converters

If the NO concentration is measured and the sample gas also contains NO_2, some applications may require the measurement of the NO_2 portion in combination with the NO portion. This can be done by installing a "NO_X converter" in the sample gas path which converts NO_2 to NO in a thermic-catalytic process. Thus a NO gas analyzer will actually determine the "NO_X" concentration ($NO_X = NO + NO_2$).

16.5.2 Disturbing effects with NO_X converters

Thermal re-conversion

The thermal conversion of NO_2 to NO is reversible. This means the effect of the NO_X converter can be partially lost when the sample gas is allowed to cool down strongly before it reaches the gas analyzer.

Remedy: Ensure the gas path between NO_X converter and gas analyzer is as short as possible.

Conversion of other gases

Other gases could possibly be converted in the same way. This applies to CO/CO_2, for example. An unwanted conversion would distort the measured values of such measuring components.

Remedy: Use a low-temperature NO_X converter with a molybendum catalyst when your S700 is also measuring CO and/or CO_2. If a high-temperature converter or a converter with a graphite catalyst is used, the CO and CO_2 measured values would be not be correct.

16.6 Creating an interface connection with a PC

16.6.1 Connecting a single analyzer directly via interface

This connection requires at least three electrical lines (TXD → RXD, RXD → TXD, GND → GND; see Fig. 10, page 182). Short out the CTS–RTS and DSR–DTR connections on the PC (install wire bridges in the plug connector of the connecting cable; see Figure). To use the “RTS/CTS protocol” for data transmissions (Windows designation: “Protocol: Hardware”), install three further connection lines (see Figure); the shorting jumpers are then not required.

16.6.2 Connecting several analyzers via bus converter

An RS422 BUS connection is required to control several gas analyzers from one PC interface (see Fig. 10, page 182). Each connected device will need one RS232C/RS422 BUS converter. These are available from various manufacturers.

The BUS converter connected to the PC must operate as “data circuit-terminating equipment“ (DCE). The BUS converters connected to the gas analyzers must operate as “data terminal equipment“ (DTE). Many BUS converters allow you to select between these modes. Set-up the BUS converters accordingly or use the appropriate BUS converter versions. – Most BUS converters need an external power supply (not shown in the Figure).

When using BUS converters, the “RTS/CTS protocol” must be activated in the gas analyzer (see “Digital interface parameters”, page 124).

16.6.3 Connecting a single analyzer via modem

Modems enable data transmission via telephone lines; two modems are needed for the connection (see Fig. 35, page 233). You can use any type of modem which has a Hayes-compatible command set. – Menu functions for setting the correct modem parameters are available in the S700.

16.6.4 Connecting several analyzers via bus converter and modem

This version combines modems and BUS converters (see Fig. 35, page 233). Please refer to the notes above.

The type of connection to be used must be programmed in the S700 (see “Setting the installed connection”, page 129).

16.6.5 Setting suitable interface parameters

→ see “Setting interface parameters (overview)”, page 190

Fig. 34: Connection of gas analyzer and PC, without modems

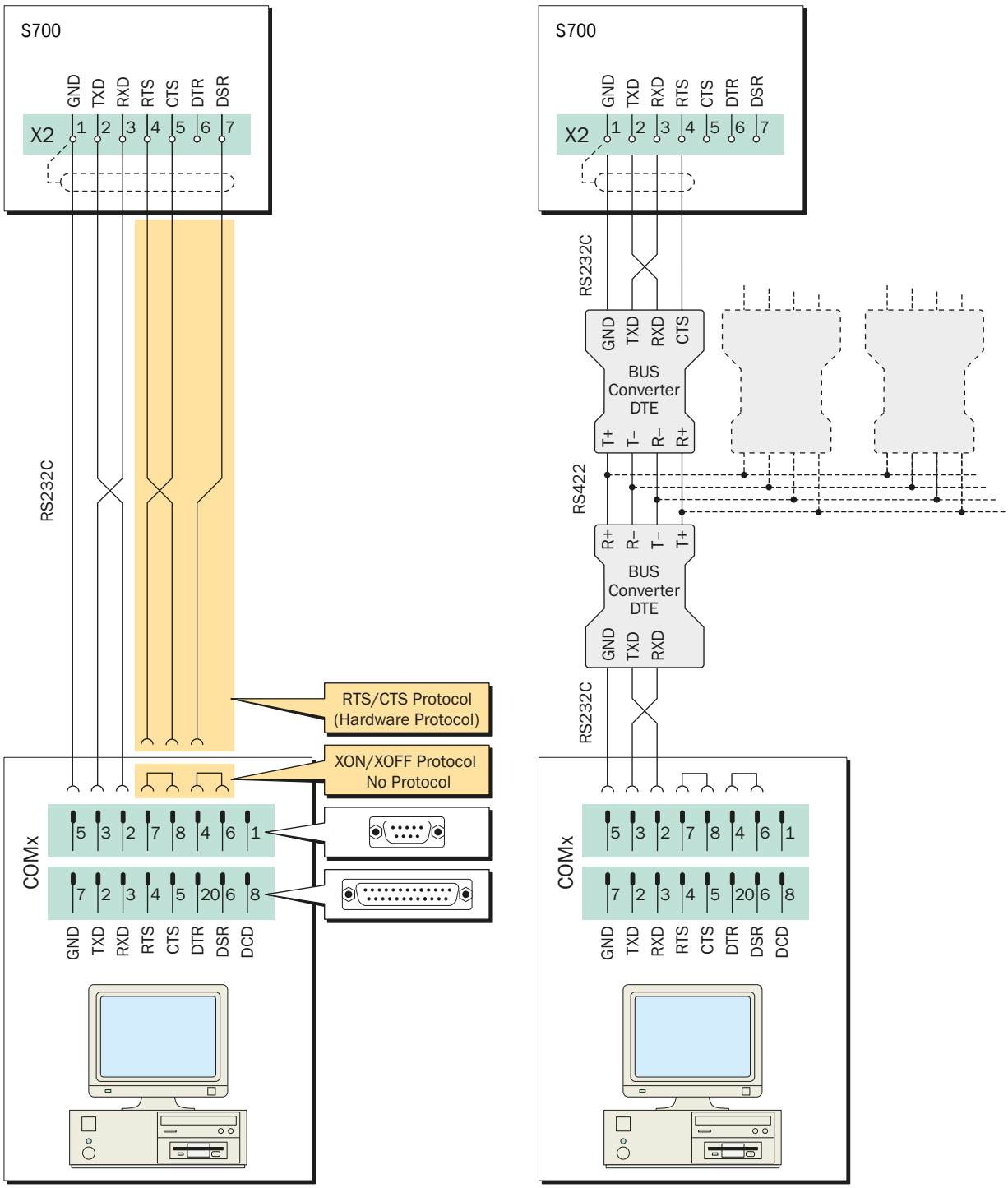
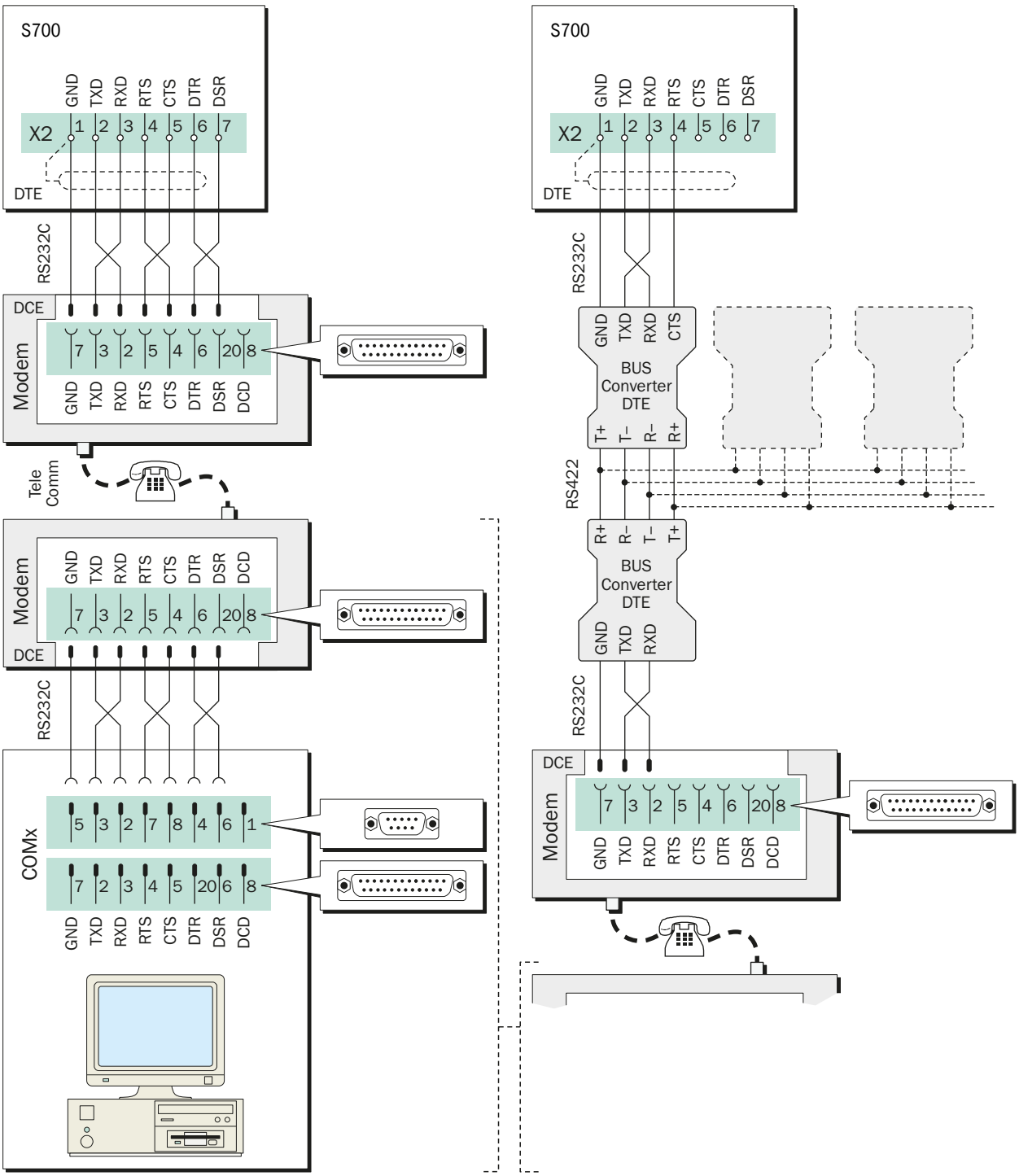


Fig. 35: Connection of gas analyzer and PC via modems



17 Custom configuration tables

17.1 User Table: Measuring components and calibration gases

□ S710 □ S711 □ S715 □ S720 Ex □ S721 Ex	Device no.:

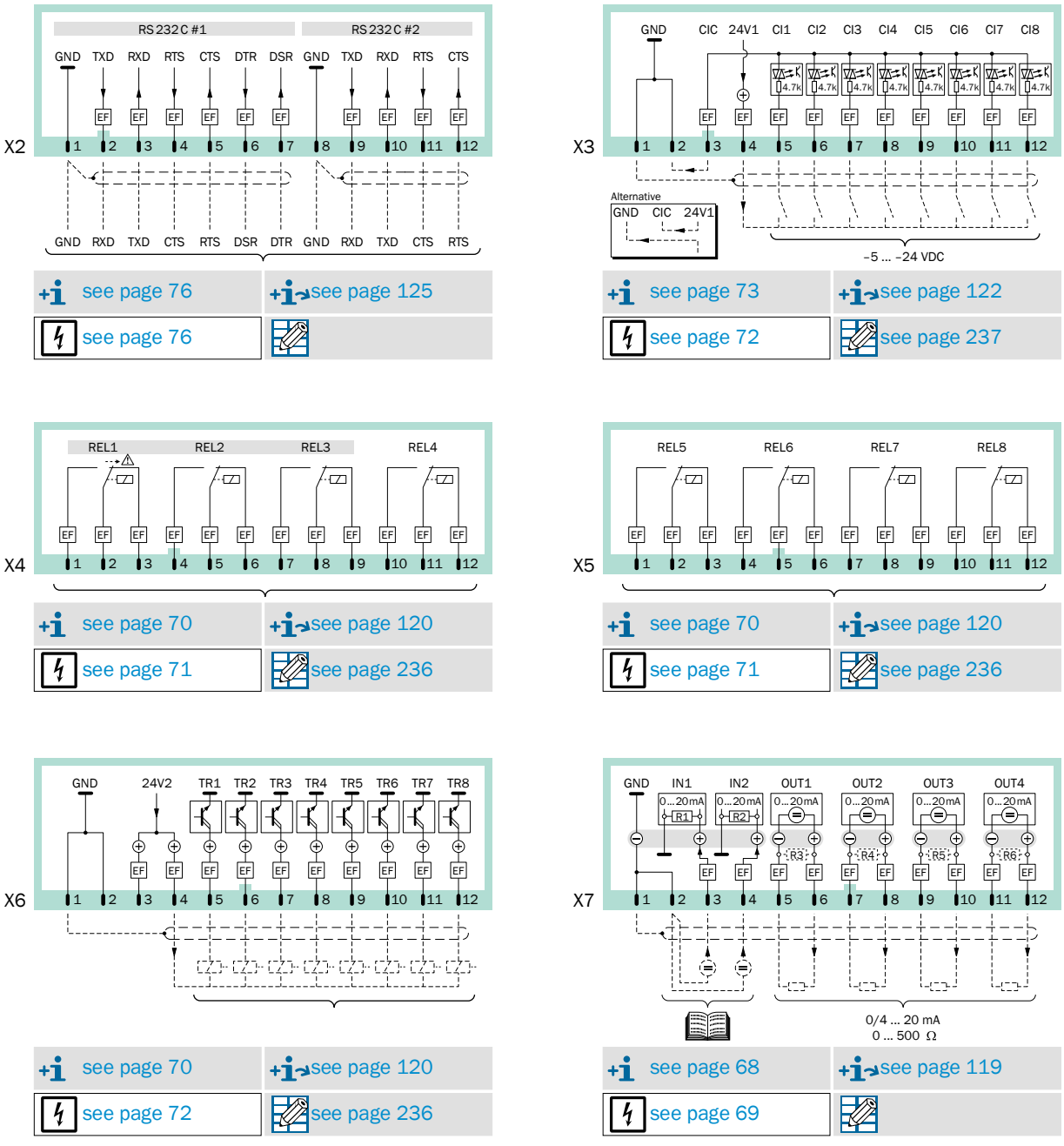
		Measuring component					Remarks
		1	2	3	4	5	
Name/Formula:							
Measured with analyzer module:		□ UNOR □ MULTOR □ OXOR-P □ OXOR-E □ THERMOR □	□ UNOR □ MULTOR □ OXOR-P □ OXOR-E □ THERMOR □	□ UNOR □ MULTOR □ OXOR-P □ OXOR-E □ THERMOR □	□ UNOR □ MULTOR □ OXOR-P □ OXOR-E □ THERMOR □	□ UNOR □ MULTOR □ OXOR-P □ OXOR-E □ THERMOR □	
Physical unit for measured value:		□ ppm □ vol.-% □ mg/m³ □ g/m³ □	□ ppm □ vol.-% □ mg/m³ □ g/m³ □	□ ppm □ vol.-% □ mg/m³ □ g/m³ □	□ ppm □ vol.-% □ mg/m³ □ g/m³ □	□ ppm □ vol.-% □ mg/m³ □ g/m³ □	
Nominal values for calibration gases	Zero gas 1						
	Zero gas 2						
	Test gas 3						
	Test gas 4						
	Test gas 5						
	Test gas 6						

17.2 Signal connection overview

NOTE:

▶ Only use this overview when you are familiar with the related comprehensive safety information (see references in the Figure).

Fig. 36: Signal connection overview



17.3 User Table: Switching outputs

☐ S710 ☐ S711 ☐ S715 ☐ S720 Ex ☐ S721 Ex	Device no.:

Function f (see "Available switching functions", page 121)		REL1		REL2		REL3		REL4		REL5		REL6		REL7		REL8		TR1		TR2		TR3		TR4		TR5		TR6		TR7		TR8	
Name	Code	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!
failure	1	–	X	–	–	–	–																										
service	2	–	–	X	–	–	–																										
fault	3	–	–	–	–	X	–																										
alarm limit 1	4	–	–	–	–	–	–																										
alarm limit 2	5	–	–	–	–	–	–																										
alarm limit 3	6	–	–	–	–	–	–																										
alarm limit 4	7	–	–	–	–	–	–																										
External pump	8	–	–	–	–	–	–																										
calibration active	9	–	–	–	–	–	–																										
auto. calibration	10	–	–	–	–	–	–																										
zero gas path 1	11	–	–	–	–	–	–																										
zero gas path 2	12	–	–	–	–	–	–																										
test gas path 3	13	–	–	–	–	–	–																										
test gas path 4	14	–	–	–	–	–	–																										
test gas path 5	15	–	–	–	–	–	–																										
test gas path 6	16	–	–	–	–	–	–																										
Sample gas path	17	–	–	–	–	–	–																										
range – output 1	18	–	–	–	–	–	–																										
range – output 2	19	–	–	–	–	–	–																										
range - output 3	20	–	–	–	–	–	–																										
range - output 4	21	–	–	–	–	–	–																										
switch on pt. 1	22	–	–	–	–	–	–																										
switch on pt. 2	23	–	–	–	–	–	–																										
switch on pt. 3	24	–	–	–	–	–	–																										
switch on pt. 4	25	–	–	–	–	–	–																										
switch on pt. 5	26	–	–	–	–	–	–																										
switch on pt. 6	27	–	–	–	–	–	–																										
switch on pt. 7	28	–	–	–	–	–	–																										
switch on pt. 8	29	–	–	–	–	–	–																										
meas. value pt. 1	30	–	–	–	–	–	–																										
meas. value pt. 2	31	–	–	–	–	–	–																										
meas. value pt. 3	32	–	–	–	–	–	–																										
meas. value pt. 4	33	–	–	–	–	–	–																										
meas. value pt. 5	34	–	–	–	–	–	–																										
meas. value pt. 6	35	–	–	–	–	–	–																										
meas. value pt. 7	36	–	–	–	–	–	–																										
meas. value pt. 8	37	–	–	–	–	–	–																										
FAILURE sensor 1	38	–	–	–	–	–	–																										
FAILURE sensor 2	39	–	–	–	–	–	–																										
FAILURE sensor 3	40	–	–	–	–	–	–																										
FAILURE extern 1	41	–	–	–	–	–	–																										
FAILURE extern 2	42	–	–	–	–	–	–																										
SERVICE sensor 1	43	–	–	–	–	–	–																										
SERVICE sensor 2	44	–	–	–	–	–	–																										
SERVICE sensor 3	45	–	–	–	–	–	–																										
SERVICE extern 1	46	–	–	–	–	–	–																										
SERVICE extern 2	47	–	–	–	–	–	–																										
CALIBR. sensor 1	48	–	–	–	–	–	–																										
CALIBR. sensor 2	49	–	–	–	–	–	–																										
CALIBR. sensor 3	50	–	–	–	–	–	–																										
CALIBR. extern 1	51	–	–	–	–	–	–																										
CALIBR. extern 2	52	–	–	–	–	–	–																										
Flow sensor	53	–	–	–	–	–	–																										
Condensate sensor	54	–	–	–	–	–	–																										
Measured value output 1	55	–	–	–	–	–	–																										
Measured value output 2	56	–	–	–	–	–	–																										
Measured value output 3	57	–	–	–	–	–	–																										

17.4 User Table: Control inputs

☐ S710 ☐ S711 ☐ S715 ☐ S720 Ex ☐ S721 Ex	Device no.:

Control function f (see “Available control functions”, page 122)		CI1		CI2		CI3		CI4		CI5		CI6		CI7		CI8	
Name	Code	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!
service block	1																
auto.cal. 1 start	2																
auto.cal. 2 start	3																
auto.cal. 3 start	4																
auto.cal. 4 start	5																
cal. stop	6																
pump on/off	7																
zero gas 1 fault	8																
test gas 3 fault	9																
test gas 4 fault	10																
test gas 5 fault	11																
range – output 1	12																
range – output 2	13																
range - output 3	14																
range - output 4	15																
(no function)	16																
failure 1	17																
failure 2	18																
service 1	19																
service 2	20																
fault 1	21																
fault 2	22																
no drifts	23																
sample value hold	24																
zero gas 2 fault	25																
test gas 6 fault	26																
hold sample pt. 1	27																
hold sample pt. 2	28																
hold sample pt. 3	29																
hold sample pt. 4	30																
hold sample pt. 5	31																
hold sample pt. 6	32																
hold sample pt. 7	33																
hold sample pt. 8	34																
switch off pt. 1	35																
switch off pt. 2	36																
switch off pt. 3	37																
switch off pt. 4	38																
switch off pt. 5	39																
switch off pt. 6	40																
switch off pt. 7	41																
switch off pt. 8	42																

18 Technical data

18.1 Enclosure

18.1.1 Dimensions

Fig. 37: Enclosure S710/S711

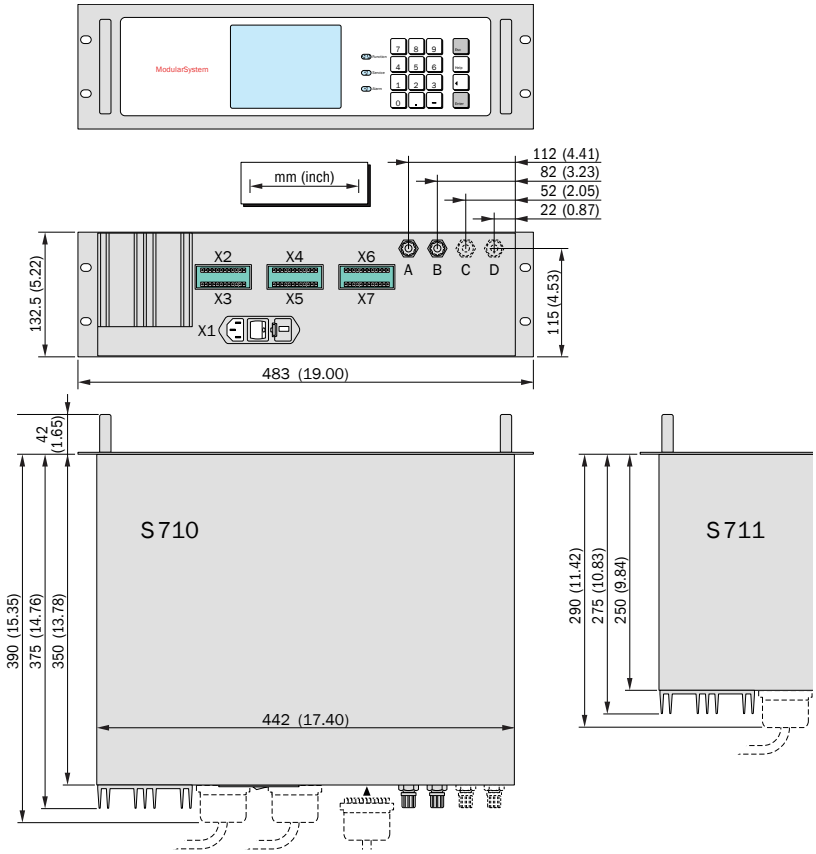


Fig. 38: Enclosure S715

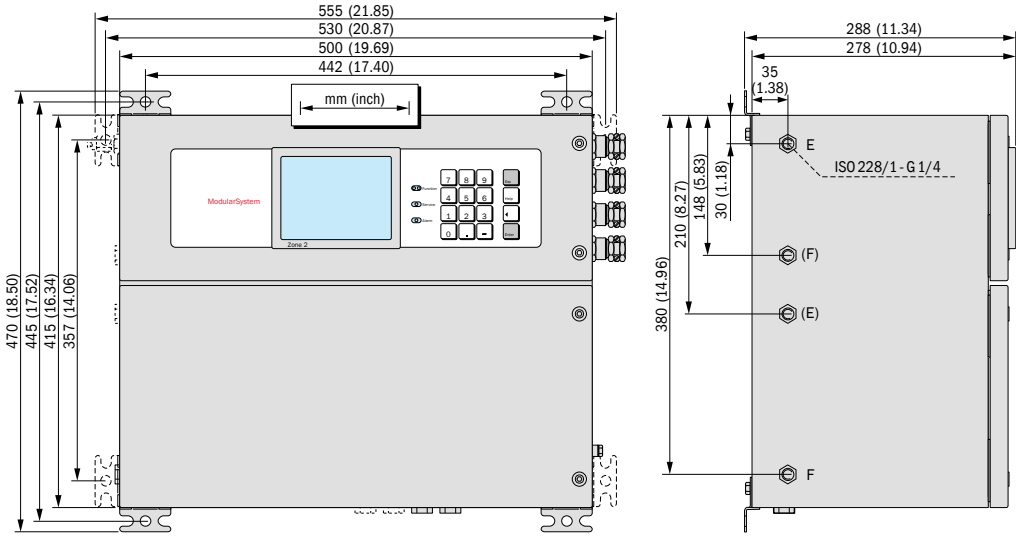
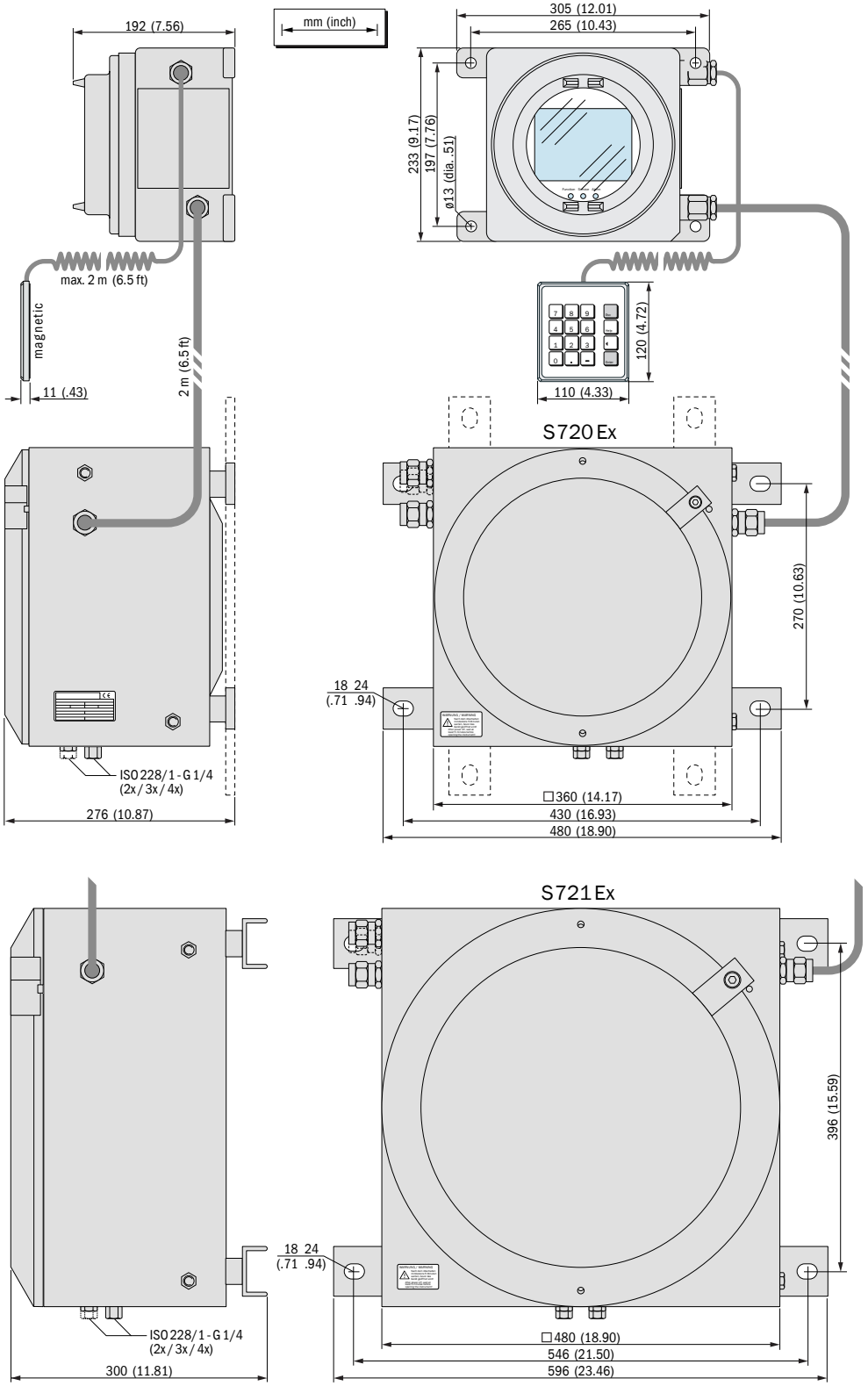


Fig. 39: Enclosure S720 Ex/S721 Ex



18.1.2 Enclosure specifications

Enclosure type	Weight	Protection class [1]	Explosion protection (identification)
S710 S710 CSA	10 ... 20 kg [2]	IP20	–
S711 S711 CSA	9 ... 19 kg [2]		
S715 standard S715 CSA	20 ... 30 kg [2]	IP65 & NEMA 4X	
S715 Ex	20 ... 30 kg [2]	IP65 & NEMA 4X	*Without intrinsically-safe measured value outputs:* II 3 G Ex nR IIC T6 Gc *With intrinsically-safe measured value outputs:*[3] II 3 G Ex nR [ib] IIC T6 Gc
S715 Ex CSA	20 ... 30 kg [2]	IP65 & NEMA 4X	Class I, Division 2, Groups A, B, C, and D, T6
S720 Ex	60 ... 70 kg [2]	IP65/7	*Without intrinsically-safe measured value outputs:* II 2 G Ex db IIC T6 Gb *With intrinsically-safe measured value outputs:* [3] II 2 G Ex db IIC T6 Gb
S721 Ex	90 ... 100 kg [2]		

[1] EN 60529
[2] Depending on the internal equipment.
[3] Option

18.1.3 Gas connections

Sample gas and span gas connections

Enclosure type	Standard gas connection	Optional
S710 S711	• PVDF bulkhead fitting for 6x1 mm hose	• Swagelok® fitting for tube with outer diameter 6 mm • Swagelok® fitting for tube with outer diameter 1/4"
S715 S720 Ex S721 Ex	• Internal thread G¼" [1]	• PVDF bulkhead fitting for 6x1 mm hose • Swagelok® fitting for tube with outer diameter 6 mm • Swagelok® fitting for tube with outer diameter 1/4"

[1] to be used for screw-in fittings

Purge gas connections

Enclosure type	Standard gas connection	Optional
S715 standard	• Internal thread G¼"	• Swagelok® fitting for tube with outer diameter 8 mm • Swagelok® fitting for tube with outer diameter 10 mm • Swagelok® fitting for tube with outer diameter 3/8"
S720 Ex S721 Ex	• Internal thread G¼"	–

18.2 Ambient conditions

Installation site · Assembly	
Atmospheric influences:	The device is intended only for indoor use
Vibrations/impacts:	The installation site should be free from vibrations and impacts
Position of use (allowed inclination of housing during operation):	Max. ±15° inclination [1] to each spatial axis

[1] Keep constant during operation; perform a new calibration after changes in the inclination.

Pressure · Temperature	
Geographic altitude of installation site:	Max. 2000 m above sea level (approx. 750 hPa)
Ambient air pressure:	700 … 1200 hPa
Operating temperature:	+5 … +45 °C (41 … 113 °F)
Storage temperature:	–20 … +70 °C (–4 … +158 °F) [1]

[1] With analyzer module “OXOR-E”: -20 … +60 °C.

Humidity · Dirt	
Relative humidity:	– annual average: ≤ 75% (short-term: ≤ 90%) – non-condensing
Permissible contamination:	– *S710, S711:* Pollution degree 1 – *S715, S720 Ex, S721 Ex:* Pollution degree 2

18.3 Electrical data

Power connection	
Power voltage [tolerance], power voltage frequency	
– Standard:	100 V AC *or*[1] 115 V AC *or* 230 V AC [– 15 % ... + 10 %], 50 ... 60 Hz
– CSA versions:	100 V AC *or*[1] 115 V AC *or* 230 V AC [– 15 % ... + 10 %], 48 ... 62 Hz
Permissible over-voltages:	Transient over-voltages in the supply network should not exceed over-voltage category II according to IEC 60364-4-443
Power input:	
– Standard:	50 VA
– With maximum equipment:	200 VA
– S720 Ex maximum equipment:	155 VA
– S721 Ex maximum equipment:	185 VA
Power cable	0.75 mm^2 ... 4 mm^2

[1] Selectable mechanically, (see “Adapting to power voltage”, page 209); adjustment of power fuse required, see “Internal fuses”, page 210.

Suitable signal cables	Cross-section
rigid	0.14 mm^2 ... 1.5 mm^2
flexible	0.14 mm^2 ... 1.5 mm^2
flexible with ferrule without plastic sleeve	0.25 mm^2 ... 1.5 mm^2
flexible with ferrule with plastic sleeve	0.25 mm^2 ... 0.5 mm^2

Electrical safety	
Class of protection:	Class of protection I [1]
Electrical safety:	Tested in accordance with EN 61010 (VDE 0411) Low Voltage Directive 2014/35/EU
Transformer:	Safety transformer according to EN 61558 (VDE 0570)
Electromagnetic compatibility:	In accordance with EN 61326-1, EN 61326-2-1, EN 61000-6-2, EN 61000-6-4 and Directive 2014/30/EU

[1] VDE 0411 Part 1 / IEC 348

Battery (to support digital memory contents)	
Battery type	Button cell BR12
Chemical system:	LI(CF)/polycarbon monofluoride lithium battery
Device variant:	S710/711, S715, S720/S721
Expected service life:	10 years

18.4 Measuring characteristics

UNOR	
description	Highly selective NDIR analyzer for continuous measurement of IR-active gas components
Measuring principles	NDIR spectroscopy
Measuring ranges	
CH_4	0 ... 100 ppm / 0 ... 100 vol.-%
CO	0 ... 20 ppm / 0 ... 100 vol.-%
CO_2	0 ... 10 ppm / 0 ... 100 vol.-%
H_2O	0 ... 1000 ppm / 0 ... 2 Vol.-%
N_2O	0 ... 50 ppm / 0 ... 100 Vol.-%
NH_3	0 ... 300 ppm / 0 ... 100 vol.-%
NO	0 ... 75 ppm / 0 ... 100 vol.-%
NO_2	0 ... 100 ppm / 0 ... 10 vol.-%
SO_2	0 ... 75 ppm / 0 ... 100 vol.-%
	Hydrocarbons (e.g. C2H2), halogenated hydrocarbons (e.g. CH2Cl2) and other gases on request
Response time t_{90}:	3 s, typically at 60 l/h, depending on the cuvette length and the gas flow rate
Sensitivity drift	≤ 1% of the measuring range end value per week
Zero drift	≤ 1% of the smalles measuring range per week
Material, with media contact	Stainless steel, aluminum, gold, CaF_2, BaF_2 PVDF, FKM, FFKM, 2-component special adhesive
Correction functions	Manual or automatic adjustment with test gases or adjustment cuvette

MULTOR	
description	Multi-component NDIR analyzer for continuous measurement of up to 3 IR-absorbing gases and H_2O for internal cross-sensitivity correction
Measuring principles	NDIR spectroscopy
Measuring ranges	
CH_4	0 ... 470 ppm / 0 ... 100 vol.-%
CO	0 ... 160 ppm / 0 ... 100 vol.-%
CO_2	0 ... 100 ppm / 0 ... 100 vol.-%
NO	0 ... 190 ppm / 0 ... 100 vol.-%
SO_2	0 ... 85 ppm / 0 ... 100 vol.-%
Response time t_{90}:	≤ 25 s, typically at 60 l/h, depending on the cuvette length, gas flow rate and number of measuring components
Sensitivity drift	≤ 1% of the measuring range end value per week
Zero drift	≤ 1% of the smallest measuring range per week

MULTOR	
Material, with media contact	Stainless steel, aluminum, gold,, CaF_2, BaF_2, PVDF, FKM, FFKM, 2-component special adhesive
Correction functions	Manual or automatic adjustment with test gases

OXOR-E	
description	Determination of the oxygen content using an electrochemical cell
Measuring principles	Electrochemical cell
Measuring ranges	
O_2	0 ... 10 ppm / 0 ... 25 vol.-%
Response time t_{90}:	20 s, typically at 60 l/h, depending on gas flow rate
Sensitivity drift	≤ 1% of the measuring range end value per week
Zero drift	≤ 2% of the smallest measuring range per week
Material, with media contact	Stainless steel, PVDF, FKM, FEP
Correction functions	Manual or automatic adjustment with test gases

OXOR-P	
Description	Accurate oxygen analyzer that works according to the paramagnetic measuring principle
Measuring principles	Paramagnetic dumbbell principle
Measuring ranges	
O_2	0 ... 1 vol.-% / 0 ... 100 vol.-% Optional: suppressed measuring ranges up to 95 ... 100 vol.-%
Response time t_{90}:	≤ 4 s, At 60 l/h gas flow rate
Sensitivity drift	≤ 1% of the measuring range end value per week
Zero drift	≤ 1% of the smallest measuring range per week Measuring range less than 5 vol%: ≤ 0.05 vol% per week
Material, with media contact	Glass, stainless steel, PVDF, FKM, platinum, nickel
Correction functions	Manual or automatic adjustment with test gases
Remarks	Special versions are available with particularly solvent-resistant or particularly corrosion-resistant measuring cells

THERMOR	
Description	Thermal conductivity analyzer for determining concentrations in binary or quasi-binary gas mixtures
Measuring principles	Thermal conductivity measurement
Measuring ranges	
H_2 in Ar	0 ... 1 vol.-% / 0 ... 100 vol.-%

THERMOR	
H_2 in CH_4	0 ... 1 vol.-% / 0 ... 100 vol.-%
H_2 in CO_2	0 ... 1 vol.-% / 0 ... 100 vol.-%
H_2in blast furnace gas	0 ... 1 vol.-% / 0 ... 100 vol.-%
H_2 in N_2	0 ... 1 vol.-% / 0 ... 100 vol.-%
H_2 in O_2	0 ... 1 vol.-% / 0 ... 100 vol.-%
	Other measuring ranges and components on request
Response time t_{90}:	≤ 20 s, at 60 l/h gas flow rate
Sensitivity drift	≤ 1% of the measuring range end value per week
Zero drift	≤ 1% of the smallest measuring range per week
Material, with media contact	Glass, stainless steel, PVDF, 2-component special adhesive
Correction functions	Manual or automatic adjustment with test gases

18.5 Gas technical requirements

Sample gas properties	
Permissible sample gas temperature: [1]	0 ... 45 °C (32 ... 113 °F)
Permissible sample gas dew point:	Below ambient temperature
Particles in the sample gas:	Sample gas should be free from dust and aerosols [2]
Permissible sample gas pressure [3]	
– internal gas paths hose-connected:	–20 ... +30 kPa (–200 ... +300 mbar) [4]
– internal gas paths tube-connected :	–20 ... +100 kPa (–200 ... +1000 mbar) [5]
– with analyzer module “OXOR-E”:	–20 ... +30 kPa (–200 ... +300 mbar)
– S720 Ex/S721 Ex:	–20 ... +10 kPa (–200 ... +100 mbar)
Sample gas flow [1]	
– minimum:	– 5 l/h (85 cm3/min)
– maximum:	– 100 l/h (1660 cm3/min)
– recommended:	– 30 ... 60 l/h (500 ... 1000 cm3/min)
– standard:	– 60 l/h (1000 cm3/min)

[1] should be constant during operation
[2] when entering the gas analyzer
[3] relative to the ambient/atmospheric air pressure
[4] *Exception:* S720 Ex/S721 Ex (see below).
[5] *Exceptions:* With analyzer module “OXOR-E”, S720 Ex/S721 Ex (see specifications below).
[6] The use of flame arresters can lead to an impairment of the measurement performance.

Features of the purge gas	Permissible value
Purge gas condition for purge cuvettes	Pressure: max. 15 mbar Temperature: 5 … 40 °C
Purging gas condition for enclosure purging	Pressure: – **S715**: max. 15 mbar – **S720 Ex** / **S721 Ex**: max. 100 mbar Temperature: 5 … 40 °C Flow: 10 … 30 l/h

Special conditions with analyzer module “OXOR-E”	
Minimum humidity (H_2O) in sample gas in continuous operation:	> 0.5 % abs. [1]
Maximum permissible operating time with lower humidity:	Max. 7 days [1]

[1] Reference value.

Built-in gas pump (option)	
Type of construction:	Oscillating diaphragm pump
Flow rate: [1]	max. 60 l/h (with 100 hPa pressure difference)

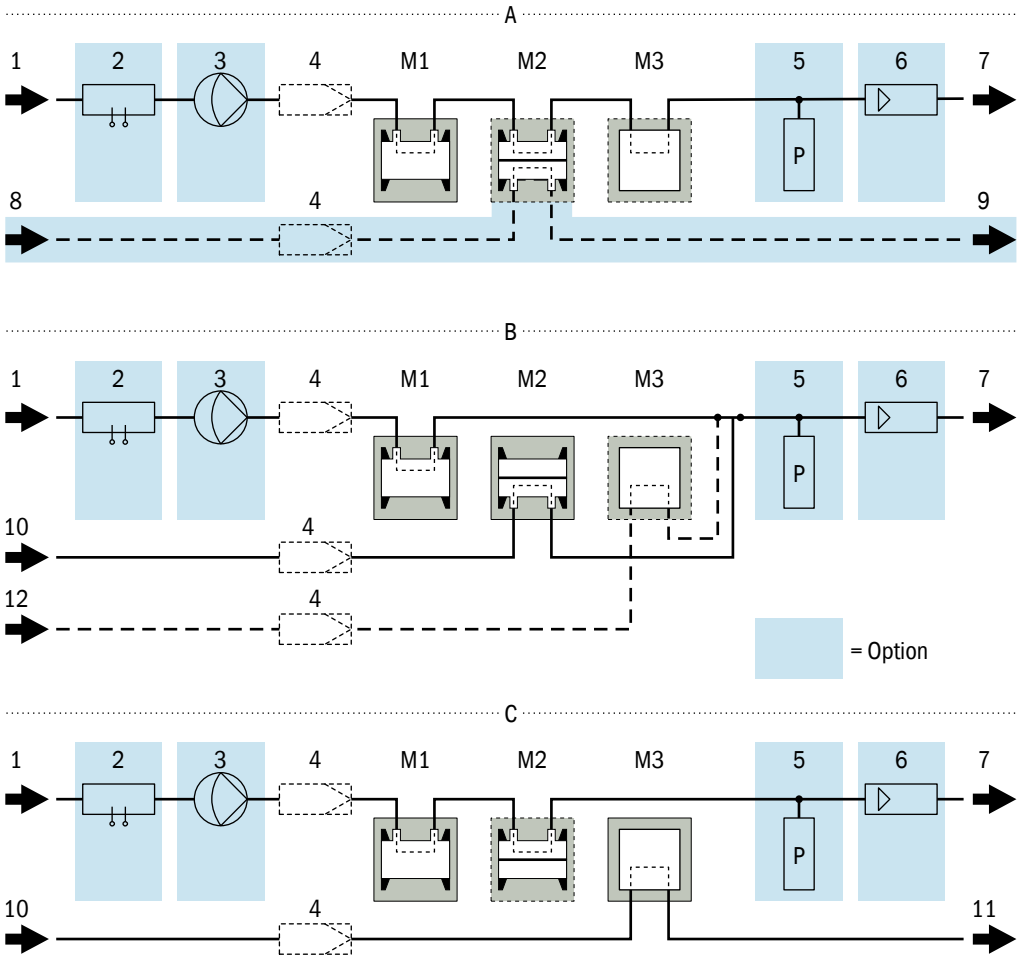
[1] Pump power adjustable via menu function, see “Setting the gas pump capacity”, page 137.

18.6 Internal gas path

18.6.1 Flow plan

The internal gas path depends on the number and type of built-in analysis modules and the desired configuration. Standard flow schematics are shown in „Internal gas flow (standard flow schematics)“. Other configurations are possible according to customer and application requirements.

Fig. 40: Internal gas flow (standard flow schematics)



-A-	Analyzer module serial: 1 sample gas path (option: 1 span gas path)		
-B-	Analyzer module parallel: 2 or 3 sample gas inlets, 1 sample gas outlet		
-C-	Two sample gas paths, completely separated		
M1	Analyzer module #1 (Standard: UNOR, MULTOR)		
M2	Analyzer module #2 (Standard: UNOR, MULTOR)		
M3	Analyzer module #3 (Standard: OXOR, THERMOR)		
1	Sample gas inlet	7	Sample gas outlet
2	Condensate sensor	8	Span gas inlet
3	Gas pump	9	Span gas outlet
4	Safety filter	10	Second sample gas inlet
5	Pressure sensor	11	Second sample gas outlet
6	Flow sensor	12	Third sample gas inlet

18.6.2 Materials with sample gas contact

Table 25: Materials with sample gas contact[1]

Subassembly	Material
UNOR/MULTOR	Stainless steel, aluminum, gold,, CaF_2, BaF_2, PVDF, FKM, FFKM, 2-component special adhesive
OXOR-P	Glass, stainless steel, PVDF, FKM, platinum, nickel
OXOR-E	Stainless steel, PVDF, FKM, FEP
THERMOR	Glass, stainless steel, PVDF, 2-component special adhesive
Moisture sensor	Glass, stainless steel, platinum, 2-component special adhesive
Flow sensor	Glass, stainless steel, PVDF, 2-component special adhesive
Sample gas pressure sensor	Stainless steel, PVDF, FKM, PVC
Sample gas pump	PTFE, FKM, EPDM, neoprene
Gas paths	Stainless steel, FKM

[1] Depending on the configuration of the S700 analyzer, a device-specific selection of the materials listed here is installed.

19 Glossary

AC	Alternating Current
ATEX	Atmosphères Explosibles: Atmosphères Explosibles: Abbreviation for European directives related to safety in potentially explosive atmospheres.
CSA	Canadian Standards Association (www.csa.ca)
DC	Direct Current
Firmware	Internal device software; mainly stored in volatile memory (EEPROMs)
IP*ab*	International Protection (also: Ingress Protection); degree of protection of a device according to IEC/DIN EN 60529. *a* designates protection against contact and impurities, *b* protection against moisture.
LED	Light emitting diode (small indicator lamps)
NAMUR	Abbreviation for “Normen-Arbeitsgemeinschaft für Mess- und Regeltechnik in der chemischen Industrie”, now “Interessengemeinschaft Automatisierungstechnik der Prozessindustrie” (www.namur.de)
NDIR	Non-dispersive infrared; Designation for optical gas analysis methods in infrared spectral range
Viton	DuPont Performance Elastomers trademark for materials made out of Fluorcarbon rubber

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